REPLY TO THE QUESTIONNAIRE REGARDING FUTURES STUDIES

PRESENTED TO

THE SENATE SPECIAL COMMITTEE ON SCIENCE POLICY

BY THE

NATIONAL RESEARCH COUNCIL OF CANADA

31 DECEMBER 1975

NATIONAL RESEARCH COUNCIL OF CANADA

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THE SENATE
CANADA

Du Key.

22 October 1975

Dr. W.G. Schneider
President
National Research Council
of Canada
Montreal Road
Ottawa, Ontario
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Dear Dr. Schneider,

Re: Futures Studies Activities

In my letter to you dated September 23, 1975 regarding science policy, I indicated that I would send you a separate letter accompanied by a questionnaire on the futures research activities of your organization.

If you want to have the background of the present letter, you should refer again to the report that our Committee presented to the Senate on July 10, 1975. You have already received a copy of that document. In addition, a copy of our paper entitled, "Managing the Future: Conference on Anticipatory Institutions" will be sent to you upon request.

As you will see in that report, our interest in futures studies and information goes back to 1972 and has taken a major portion of our time since 1974. You will also note that the leadership role we had assumed in this area, because of the vacuum which then existed, has now been assigned to the Institute for Research on Public Policy. We have therefore decided to maintain our interest in this field but to fulfill a watchdog role. In making a survey of futures studies within the federal government, as part of its broader mandate, the Committee's specific objectives are:

1. to help develop coordinated national networks of futures research,

2. to consider how best the on-going activities in the futures studies area, within the federal government, can be monitored to ensure, insofar as this can be done, that coordination will be effectively achieved, and

3. to assess the catalytic and residual role of the Institute for Research on Public Policy in the development of these national networks.

The Committee needs your assistance in making its survey and I am hereby inviting you to respond to the enclosed questionnaire to the extent that the information requested is relevant to the activities of your organization. It might facilitate matters if you would identify for us a person on your staff with whom our personnel could establish and maintain contact.

We hope to obtain your response to the questionnaire, together with any additional comments that you may wish to make, as soon as possible, but not later than the end of December.

You will share our view, I am sure, that it is extremely important for Canada to develop a coherent futures studies program and to make sure that such research will have its full impact on decision making. The Committee believes that it is essential for a parliamentary group to participate in such a development and will welcome your support.

Yours sincerely,

Maurice Lamontagne

Maurice Lamontagne.

Encl.

QUESTIONNAIRE REGARDING FUTURES STUDIES

(You will undoubtedly appreciate the difficulties involved in the preparation of a questionnaire on such a new and still ill-defined topic as futures studies and their use in decision making. Moreover, because of our small staff, we have not been able to prepare different models of the questionnaire designed to fit the particular conditions of various types of organizations. If you find that the questions are too general, are not applicable as stated to your organization, or do not cover the subject as you see it, do not hesitate to rephrase them or add to them.)

1. Futures studies can be defined as systematic research through one or more methodologies, into indicative or normative medium term and long term futures for the purpose of identifying threats and opportunities and providing a broader and less short-sighted basis for decision making.

   Is this definition acceptable to you?
   If not, give the alternative that you prefer.

2. Does your organization use the term futures studies for the type of activity described above or an alternative (e.g., futures research, futurology, futuristics or forecasting). Please state alternative if one is used.

3. Does your organization conduct or sponsor any futures studies?

A. The Planning of Your Futures Studies

4. How do you perceive your needs for futures studies? (Advocates of futures studies make the following assertions:

   a) These studies can provide an "early warning" system and help identify emerging problems that might become crises.

b) They can provide an information environment which will help managers to broaden the basis and extend the time horizon of their decision-making process, thus increasing the probability that their actions will have their intended effects and impacts.

c) Futures studies help develop a sensitivity to change, an understanding of the process of change and the ability to react to change, thus generating a greater capability within management to make more quickly the internal organizational improvements necessary for successful goal accomplishments.

If you agree with this perception of needs that can be met by futures studies, list them in terms of your own priorities and explain why. If you do not agree, indicate the needs that would better reflect the experience and perception of your organization.)

5. How are futures studies planned and initiated in your organization; do your senior managers actively participate in that planning or is the initiative left to researchers?

6. Before initiating a futures research program, how do you make sure that the need you have in mind is not already met by existing studies made in Canada or abroad; do you have access, for instance, to a monitoring service giving you information on research done or going on elsewhere in the area that concerns your organization?

B. Your Futures Research Programs

7. How many futures studies groups operate within your organization? Please describe the specific needs which any one group is expected to meet and give details regarding staff, budgets, disciplines and projects involved and any other information you believe would be valuable concerning your current activities in this area.

8. Does your organization retain consultants or outside contractors to meet your research needs in this area? In the affirmative, describe the main features of the contracts which have been awarded in 1974 and 1975 (name of contractors, nature of projects, amounts involved, etc.)

9. Are you offering grants upon request to outside organizations in order to support their own futures studies activities? In the affirmative, describe the guidelines that you apply and the general features of the grants that have been awarded in 1974 and 1975 in the same manner as in (8).

10. Do you envisage to maintain or increase the budget devoted to futures studies during the next few years and if so,

    a) in response to what needs?
    b) in what form of expenditures: in-house, contracts or grants? Explain.

11. What are the futures studies methodologies being utilized by your staff (the Delphi mehtod, extrapolation of trends, morphological analysis, scenarios, cross impact matrices, the dynamic forecasting model developed by Jay Forrester and others)?

12. Have you conducted any work in order to improve and extend a particular methodology? Describe briefly.

13. Is the main technological assessment effort for your organization conducted within your futures studies group(s), within your organization by a separate group, or under contract by outside consultants?

14. Give us a brief list of books, articles or reports that you have found to give a useful account of the nature and scope of futures studies and their introduction into the managerial or decision-making structure of your organization. Please limit the list to about 10 items. (This is not a request for a library bibliography but for an indication of the literature which the managers of your organization have found to be of value in their own work.)

C. Use and Diffusion of Your Futures Studies

15. How and at what level(s) are the results of futures studies fed into your decision-making structure?

16. Give some concrete case histories related to the internal use by your senior managers of the results of futures studies conducted or sponsored by your organization, including the impact they have had on decision-making.

17. What are the steps taken by your organization to ensure the best possible diffusion of its futures studies (either in-house or contracted out) within and outside of the federal government?

18. What are the main restrictions limiting the diffusion of your futures studies; do you have any suggestions for reducing those restrictions?

19. Give the title and a brief outline of the futures studies reports sponsored by your organization which are already or will be available in 1975 and 1976 to the Canadian public.

D. Futures Studies Outside Your Organization

(This section may appear to duplicate question 6. However, it should be seen as complementary and as dealing with broad or macroscopic research and with specific studies considered to be outside but related to the area of immediate concern to your organization.)

20. Do you believe that there is a need for an integrated and continuing Canadian program of macroscopic futures research which could give an overview of broad trends and alternative futures within an international outlook and serve as a framework and reference for your own specific studies?

21. If such a need exists, how in your view could it best be met (e.g., the establishment of one or more centres within or outside the federal government; the coordination of current or of extended activities of existing agencies)?

22. Do you have easy access to specific futures studies in areas related to yours and made by

    a) other government departments and agencies;
    b) non-governmental organizations in Canada;
    c) organizations outside of Canada.

23. If this access is not satisfactory, how would you propose to improve it (e.g., the creation of a Canadian information centre and relaying station with which you would be linked; assignment of this responsibility for gathering and diffusing information to an existing agency)?

24. Are your senior managers involved in periodic discussions of medium-term and long-term threats and opprotunities within the scope of your mission with colleagues working in related areas in other governmental and non-governmental organizations?

25. If such systematic discussions take place, would you describe how they are organized and indicate whether they have led to a better mutual understanding of these threats and opportunities.

26. If such discussions do not take place, do you think that there is a need for them and if so, how should they be organized?

BRIEF

BY THE

NATIONAL RESEARCH COUNCIL OF CANADA

ON

FUTURES STUDIES ACTIVITIES

PRESENTED

TO THE

SENATE SPECIAL COMMITTEE

ON SCIENCE POLICY

December, 1975

The National Research Council of Canada
Montreal Road
Ottawa : Ontario : K1A 0R6
Canada.

NATIONAL RESEARCH COUNCIL OF CANADA

REPLY TO THE QUESTIONNAIRE ISSUED BY THE SENATE SPECIAL COMMITTEE ON SCIENCE POLICY REGARDING FUTURES STUDIES.

1. The statutory responsibilities and functions, the organization, research activities and research output of the National Research Council were reported to the Committee during the earlier hearings. The situation from 1968 to date is reported concurrently.

2. The NRC has always had an implicit future orientation to its work since the results of the scientific and industrial research for which it was set up can only accrue in a future time frame.

Further, since the possibilities for research greatly exceed the available research workers, facilities or funds, the Council has had to learn to choose between different projects. To this end it has necessarily been engaged for many years in projections, forecasting and what have recently come to be called 'future studies'. The Committee will note that the need to select a relatively small number of projects in most or all of a wide range of scientific, technical and engineering disciplines, each requiring different facilities and varying costs, will colour the Council's response to the subject of 'futures studies'.

3. The term 'future studies' is far from precise. In responding to the Committee, the NRC has had to consider

whether it should discuss the relationship of a research project to a futures study, the nature of futures studies, their relationship to the process of choice and decision first; or whether it should present the answers to the questionnaire first. The NRC believes that the Committee would wish to have its answers to the questionnaire presented first and then to discuss matters arising from it and them.

Nevertheless, the NRC wishes to draw attention to the problems and nature of 'futures studies', an area currently still in a formative state. These have been well set out by the Royal Ministry for Foreign Affairs in cooperation with the Secretariat for Future Studies of Sweden in their book entitled 'To Choose a Future', Stockholm, 1974, and their cautions in regard to the strengths and weaknesses of such studies are pertinent to the following discussion.[1]

4. Questionnaire regarding Futures Studies

The following summarizes the answers to the questions as asked:

Question 1 The reasons for doubting the validity of the definition of 'futures studies' provided are given in the Swedish document referred to in section 3.

Thus, the indicative-normative dimension is only one

[1]Chapters 1 and 2 attached as Appendix A. A resource paper on the nature of futures problems is attached as Appendix B.

of several; the terms, medium- and long-term, vary in meaning according to the industry or institution concerned. There is an over-preoccupation with methodologies; methodologies should be used as appropriate, in the same way as in other fields of study.

The word 'systematic' implies a degree of objectivity and certainty which is difficult to sustain. No one can "know" the future in any absolute sense;[1] the beliefs, values and goals of the researcher affect his perception of it; analyses of past predictions and forecasts reveal not only some mistakes but also omissions – the questions which subsequent events show should have been, but were not, asked.

The NRC prefers the modern management approach which requires managers and staff to be continuously aware of the present and future options open to them in their businesses, i.e. to the future as process, based on what might be termed 'future consciousness'. Responsibility for the future is not delegated to separate bodies for study but becomes an integral part of the day-to-day operations. Special studies may be carried out from time-to-time, special committees set up, but the integration of the activity into the organization is critical.

On this basis, the process of future study is:

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[1] Toffler, A. in "The Futurists," Random House, N.Y., p.109 (1972).

Decisions have effects, intended and unintended, which persist. Management must therefore always know its present and future major options in order to react or adapt to changing events. Thus it must explore alternatives by means of 'futures studies' as an essential element in posing the choices and reaching its decisions.

The NRC preferred definition is a modification of T.J. Gordon's definition of 'futures research':

Futures studies are a means of perceiving and articulating the more important of the alternative futures and estimating the trajectory likely to be produced by contemplated policies.

Gordon notes that, in terms of this kind of operational definition, forecasting is perceived as an aid to decision-making, and he adds two caveats: there is no way to state what the future will be; and there will always be blind spots in forecasts.

Question 2 The NRC finds the term 'futures studies' too general for its normal work and prefers to use more specific terms such as technology forecasts, feasibility studies, project reviews, etc.

Question 3 Yes, see the answer to question 16.

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[1] Gordon, T.J., "The Current Methods of Futures Research," in Toffler, A. (ed.), "The Futurists," Random House, N.Y., p.165 (1972).

A. The Planning of Futures Studies

Question 4 (a) Agreed.

Question 4 (b) Agreed (simpler language is preferable: 'futures studies' help managers and staff to look and plan ahead more effectively).

Question 4 (c) This is a complex subject. Those who deal with resistance to change in organizations note that change-agents such as planners, forecasters, and futurists are highly-visible and that actions to neutralize them and their recommendations are usually easy to organize.[1] Under these circumstances the organization of futures studies and the people chosen to do them become critical, and differing results may be obtained in different organizations and within the same organization.

Question 4 (d) The needs for 'futures studies' for a government agency such as the NRC can be set out as follows:

(i) definition of the role of NRC in relation to the future needs of Canada, including the elaboration of its 'logical future', of alternative futures, and of possible 'interventions';[2]

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[1] cf. Michael, Donald, 'Planning to Learn and Learning to Plan', Jossey-Bass, San Francisco, 197 ; Trist, Eric, 'Resistance to Innovation-Human and Organizational', Innovation Canada 74 Seminar, Elgin House, Muskoka, 1974.

[2] The terminology is that of Ozbekhan, H. in 'The Emerging Methodology of Planning', Fields within Fields, No. 40, Winter, 63-80 (1973-4);'Réflexions sur l'émergence d'une méthodologie de la planification prospective,' L'Actualité économique, 51, #2, 164-193 (1975).

(ii) definition of objectives in relation to goals and policies established internally or elsewhere;

(iii) definition of programs;

(iv) monitoring/forecasting/evaluating/assessing specific areas or fields;

(v) collating, verifying, validating information to be used in 'futures studies', by others, or required for actions, arising from them,

either for the NRC itself or in cooperation with other organizations.

Question 5 'Futures studies' are planned and initiated at a number of levels in the NRC within the general framework established by Council. Strategic 'futures studies' have been initiated at the Council and Management Committee levels as shown in the first case history presented in response to question 16. At the tactical level, technology forecasts, feasibility studies, project reviews, etc., may be initiated in any of the NRC's operating units. The initiative may come from the senior managers, group leaders or researchers, or from elsewhere. Such proposals are then subjected to a bottom-up, top-down synthesizing and filtering process before decisions are taken on them.

Question 6 Through the Council itself, its Associate and other Committees, the Industrial Research Assistance Program, membership of government committees and working

parties at all levels, participation in DSS Unsolicited and Make-or-Buy Programs, membership of industry and association committees of all types, consultation with or for companies, its grants program with universities, and through other national and international agencies, the NRC is constantly informed or consulted on what have usefully been termed 'questions of the times' in the scientific and technical fields.

To fill in areas not currently covered, it is a member of the Stanford Research Institute's Long-Range Planning Service and consults with such bodies as the Science Council of Canada, the Economic Council of Canada, the National Science Foundation, the National Bureau of Standards, etc.

The Canada Institute for Scientific and Technical Information (CISTI) is the repository for scientific and technical information in a wide range of fields, and publishes a directory of all federally-supported research in universities (including any 'futures studies') and a bibliography of publications on "Scientific policy research and development in Canada" which includes inter alia, technological forecasting.[1] CISTI has also developed a

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[1] 'Scientific Policy, Research & Development in Canada', Supplement June 1972 - June 1975, NRC 14949; 'The Directory of Federally-supported research in universities', NRC-14570, Ottawa, annual.

computerized network of scientific and technological information services which could accept into its databanks inputs from a unit or agency with a mandate to compile a register of Canadian publications in this field.

The Division of Building Research provides a monitoring service to the construction industry in Canada through its Building Research News, which deals with all matters of interest to the industry.

In addition, individuals in NRC are members of futures-oriented bodies such as the Canadian Association for the Club of Rome, the World Futures Society, the Ottawa Futures Society, the North American Society for Corporate Planning, the Advanced Concepts Centre of the Department of the Environment. They are also on the Advisory Board of journals such as Technological Forecasting & Social Change, participate in futures-oriented conferences such as that held in Ottawa in February, 1975, on 'Technology and Growth: an exploratory dialogue on technology assessment and the limits to growth', participate in seminars on technology forecasting, etc., in Canadian universities and elsewhere.

Other members of the NRC participate in futures work through membership in societies and associations.

B. Your Futures Research Programs

Question 7 The NRC has not found it appropriate to establish a separate permanent 'futures studies' group as explained

in the answer to question 1. Any such groups have been set up internally as required, for example at the request of Council, the Management or Tactical Studies Committee. Appropriate individuals are seconded wholly or partly for this work, but usually no separate budgets or allocations are made.

Question 8 Yes, on occasion, e.g.

Contract No. 031385 awarded to Dr. K.F. Tupper in the amount of $17,800 on 27 May, 1975, for 'An energy-related R&D program and study' in relation to the interdepartmental R&D program concerning the future of energy sources in Canada.

Question 9 In the course of considering proposals for grants to support research of broad national significance, it may be necessary to identify more clearly the nature and scope of the problem in relation to present and future conditions in Canada. In these circumstances a number of feasibility studies have been funded by the NRC in the past, but none in the years 1974* and 1975.

In each of these cases, the objectives, guidelines and scope of the studies appropriate to the research area involved, have been established between the grantees and NRC. Publication of the results of such studies is encouraged. Thus, in September, 1974, the final report to the Advisory Committee comprising industry, government and Concordia University representatives on "Building Research and Building

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*One study was completed in the fiscal year 1974, dealing with "A Review of the Status of MHD Power Generation Technology", (P.C. Stangeby, University of Toronto Inst. for Aerospace Studies, Grant # A-8853 1973/4 $16,520).

Engineering" was published, dealing with the potential contributions and development of university research in this field.

Question 10 The budget contains no specific provisions for 'futures studies' as such at this time. Any such studies are treated as part of the currently approved program (cf. the reply to question 7).

Question 11 Various members of NRC's staff have used one or other of the methodologies listed as shown in the list of publications, reports, internal memoranda, etc., in answer to question 19. These include relevance trees, trend extrapolation, cross-impact matrices, Delphi, simulation modelling, scenarios, etc., and new methodologies and developments.

Question 12 One new methodology has been developed, one is being developed, and two important extensions are now available.

(i) Validation of Simulation Models

The time and cost of simulation models used for forecasting can be materially reduced and their accuracy increased if critical parameters in the model can be identified in advance. In practice this means knowing which parameters need to be measured to what degree of accuracy and which do not. Dr. D.R. Miller of the Division of Biological Sciences has shown that this can be achieved by sensitivity analysis and has applied the results to the

biological control of mosquito populations and to predictions concerning pollutant behavior in rivers (the Ottawa river project being carried out by the University of Ottawa and the NRC).

(ii) Live Modelling

The network planning and implementation group of the NRC's scientific and technological information program has the task of improving the linking together of existing information services to meet the needs of users. This has proved to be a most unusual problem, there being a widely held belief stemming from the free public lending library and 'free' academic information that knowledge should remain free. However modern methods enable selected information to be recovered very much more quickly than the individual can do for him- or herself, but at a cost. The solution has been the development of a live modelling process in the form of a pilot project to establish the needs and the best means of responding to the needs of users of scientific and technical information in Canada. The method is termed live modelling since there is no way at present whereby people can gauge their likely use of, and willingness to pay for, a service they have never previously experienced.[1]

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[1] The large Xerox copier and the jet passenger aircraft are the other two examples where conventional market research methods completely failed to perceive the enthusiastic acceptance of something not previously experienced by the general user or the public.

(iii) Behavior Pattern Analysis

Planners, forecasters and futurists have not generally made use of behavior patterns as a basis for forecasting and futures studies, despite the fact that this forms the basis of most human judgements. We expect people to behave in accustomed ways.

It has been shown from studies of the behavior of industries[1] that groups of industries show the same behavior pattern; that the factors which produce these same behavior patterns can be identified; and that, using these, an operational classification of industries can be derived which can then be used predictively (something not possible with the non-rational standard industrial classification).[2]

It has been shown further that, when the factors controlling a group of industries change (as has happened recently), the new behavior patterns can be predicted. Forecasts of such changes for industry in general, for the chemical and metallurgical industries, and for use by planners have been published and are listed in Appendix C.

The methodology appears capable of extension to the human services sector.

(iv) Goal-derivation

Change in industries, etc., occur on the one hand as the result of adaptation to forces acting on them, and on

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[1] W.H.C. Simmonds, 'The Analysis of Industrial Behavior and Its Use in Forecasting,' Tech. Fore. & Soc. Change, 3, 205-224 (1972); 'Industrial Behavior Patterns: a New Dimension for Planners,' Futures, 7, #4, 284-292 (1975).

[2] 'Towards an Analytical Industry Classification,' Tech. Fore.

the other, as a response to the goals of society and new perceptions of them. We have reached the end of the era of economic growth for its own sake, and need to articulate a new set of national goals. This is a process which takes considerable time.[1] It has been demonstrated[2] that a new socio-economic set of goals can be derived by treating the 1964 goals as a means to a higher set of goals, ones which include the human and the social with the economic.[3]

This new set of goals has significant implications for the relationship of science and technology to people, and suggests that we must now look much more realistically at the flexibility of technologies and at the possibilities of adapting technology to people instead of people to technology (automation).

Question 13 For projects initiated and to be carried out within the NRC, a technology assessment is included in the feasibility study. Where such studies are carried out with or for clients such as the Ministry of Transport, the Department of National Health & Welfare, the CNR, etc., technology assessments must be agreed between the parties concerned.

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[1]As the Chairman of the Senate Committee has pointed out, it took approximately twenty years to establish the 1964 Economic Council of Canada goals on a national basis.

[2]W.H.C. Simmonds, 'Evolving our New Socio-Economic Goals,' paper presented to the 2nd Annual Meeting of the Canadian Association for the Club of Rome, Ottawa, May, 1975;

[3]W.H.C. Simmonds, "Forces for Change," Innovation Canada 75, Elgin House, Muskoka, Sept. 1975, Proceedings obtainable from Innovation Canada, 533 Arbor Road, Mississauga, Ont., L5G 2J6; aussi "L'analyse des configurations du comportement industriel comme technique de prévision," L'Actualité économique, 51, #2, avril-juin, 289-321 (1975).

There is, however, a wider aspect to technology assessment which was noted by the Director of the Biological Sciences Division from his experience on the International Committee on Radiation Protection. Technology assessments and any regulations arising from them cannot be better than the quality and validity of the information going into them. This led to the Associate Committee on Scientific Criteria for Environmental Quality being established by the NRC in response to a Cabinet mandate to develop scientific guidelines for defining the quality of the environment. Through its sub-committees the Associate Committee establishes agreed answers to the question: what does a pollutor or pollutant do to an acceptor? This information is established openly between all the parties concerned.

The responsibility for Environmental Impact Assessment statements under the Environmental Contaminants 1975 Act rests with the Environmental Assessment panel of the Department of the Environment, but the Department can act on the basis of information validated before, and to, all the parties concerned.

Question 14 In regard to the broader approach to future studies,

Emery, F.E. & Trist, E.L., 'Towards a Social Ecology', Plenum Press, London, 1975.

Vickers, Sir Geoffrey, 'The Art of Judgment', Chapman & Hall, London, 1965; 'Value Systems and Social Processes', Allen Press, London, 1968; 'Freedom in a Rocking Boat: Changing Values in an Unstable Society', Allen Press, 1973; 'Making Institutions Work', Halsted Press, 1973.

Royal Ministry for Foreign Affairs, 'To Choose a Future', Stockholm, Sweden, 1974.

In regard to futures methodologies and technology forecasting,

Ayres, R.U., 'Technological Forecasting and Long-range Planning', McGraw-Hill, 1969.

Bright, Jas. & Schoeman, M.E.F., eds., 'A Guide to Practical Technological Forecasting', Prentice-Hall, N.Y., 1973.

In regard to futures thinking at the management, planning, and decision-making level,

Beer, Stafford, 'The Brain of the Firm: A Development in Management Cybernetics', McGraw-Hill, 1972; 'Platform for Change', Wiley-Interscience, 1975.

Dailey, C.A., 'Entrepreneurial Management', McGraw-Hill, N.Y., 1971.

Jantsch, E., 'Technological Planning and Social Futures', Cassell, London, 1972.

In a specific area such as simulation modelling,

Jeffers, J.N.R. (ed.), 'Mathematical Models in Ecology', Blackwell, 1972.

In regard to articles, the following journals,

'Technological Forecasting & Social Change', American Elsevier, N.Y.

'Futures', The Institute for the Future & IPC Science & Technology Press, U.K.

'The Futurist', World Future Society, Washington, D.C.

C. Use & Diffusion of Your Futures Studies

Question 15 The results of 'futures studies' or future-related studies carried out within NRC or in association with others are reported to the appropriate levels within the organization, e.g.: the Council, senior officers, directors or group leaders.

Question 16 Four case histories follow. They are:

(i) The reorganization of NRC in the light of the P.P.A.G. study 'The Future Role of NRC'.

(ii) Miles from Anywhere - How a Regional Laboratory constructs a Future for its Community.

(iii) The Oldest Technology - Given a New Future!

(iv) Energy for the Future - NRC's contribution to this Complex Problem.

(i) 'The Future Role of the NRC'

In 1968 the NRC was reorganized along functional lines as shown in Figure 1.[1] The new post of Délégué-Général was created, the responsibilities of which included 'the formulation of long-range policies and plans, both for the research activities of the NRC laboratories, and for the support and encouragement of research in universities and industry'.[2] It will be recalled that during this period Treasury Board was introducing the PPBS system into the Public Service, and appropriate objectives, sub-objectives and program description were established for the NRC.[3]

The Program Planning and Analysis Group (PPAG) was set up in the office of the Délégué-Général in mid-1970 to study among other questions 'The Future Role of the NRC'. In 1972 the work and its conclusions were passed to the Management Committee and to Council. After a series of consultations and discussions with Council, the laboratory directors and staff, a new organization was evolved with a revised set of objectives, sub-objectives and program description (Figure 2).

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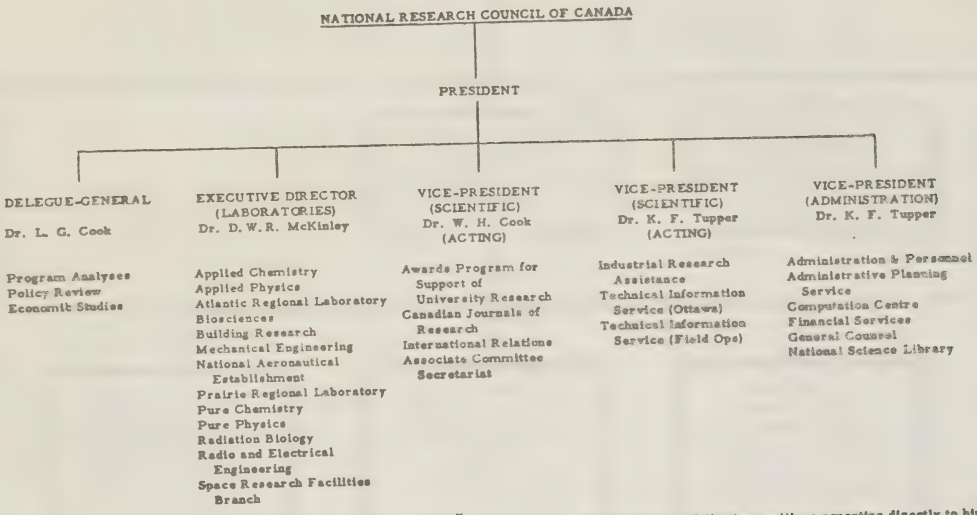
[1] Appendix B from Hearing No. 3, 23 Oct., 1968, Senate Special Committee on Science Policy, p. 146.

[2] Report of the President, 1968/9.

[3] See the annual Treasury Board Estimates for these.

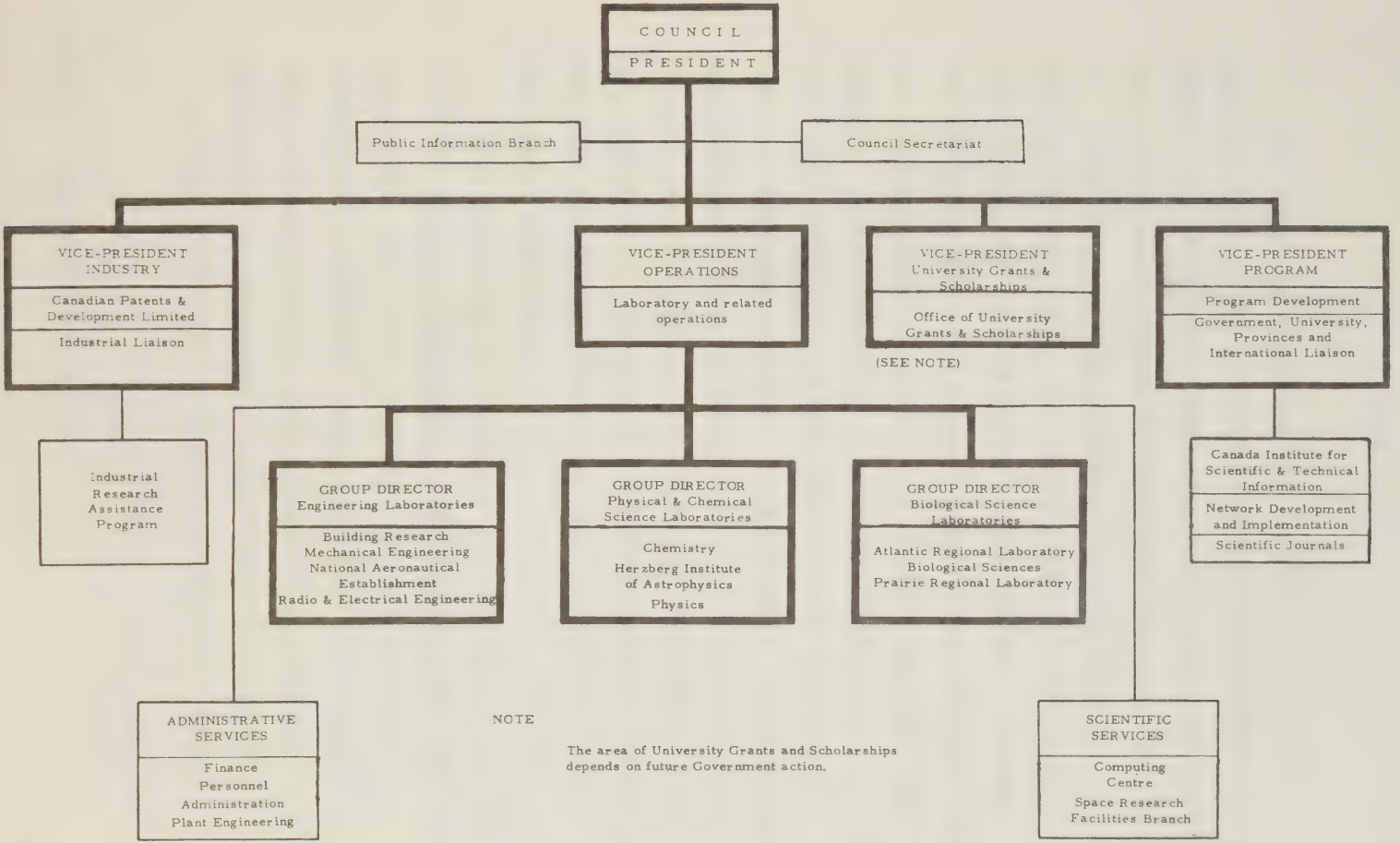
FIGURE 1 - ORGANIZATION OF THE NATIONAL RESEARCH COUNCIL IN 1968



FOOTNOTE: In addition to the five positions at the Vice-Presidential level, the President also has the following positions reporting directly to him:- Executive Assistant, Chief of Information Services, and the Secretary of the Council.

13.9.68

FIGURE 2 - REORGANIZATION OF THE NATIONAL RESEARCH COUNCIL, 1974-5



NOTE

The area of University Grants and Scholarships depends on future Government action.

1.11.74

The PPAG was subsequently disbanded, and the responsibilities for strategic planning was assumed by Council and Management Committee, and for tactical planning by the newly formed Tactical Studies Committee.[1]

The Tactical Studies Committee comprises the three group directors, one responsible for the four engineering and applied science laboratories, a second for the three physical science laboratories, and the third for the biological sciences plus the two regional laboratories. The NRC has thus a functioning research planning mechanism which can consider the relative merits and needs of different projects and proposals. In each case, the laboratory director appointed as group director has to look at a broader set of interests than those of his own laboratory. The Tactical Studies Committee reports to the Vice-President, Operations, and through him to the Management Committee.

The mechanism for handling the results of 'futures studies' whether internally or externally-generated, is accordingly built in as an integral part of NRC's operational structure. Some results of this approach include a more sharply focussed set of objectives; major projects have been, or are being put together on an inter-disciplinary and inter-laboratory basis

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[1]Report of the President, 1974/5.

including programs in such areas as energy,[1] food,[2] transportation,[3] and support for social objectives;[4] several groups of scientists in different disciplines have been integrated into the new Herzberg Institute of Astrophysics;[5] CISTI's present and future program and projects have been redefined and clarified in the light of Cabinet priorities.

This history illustrates the need in NRC for different kinds of 'futures studies' at different times in response to the extraordinary range of technology and science and their penchant for turning up at expected and unexpected points in the economy and society.

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[1] The NRC is actively participating in the Task Force on Energy R&D.

[2] An interdepartmental arrangement to deal with R&D in this field is in hand.

[3] The NRC is participating in the current review of federal government transportation R&D.

[4] The NRC is working with Canadian Association of Chiefs of Police to guide R&D in the areas of public safety and public security.

[5] Several fields of related research in different NRC laboratories have been brought together through the formation of this Institute, named in honour of Dr. Gerhard Herzberg, 1971 Nobel Prize winner in Chemistry, and now possible as one result of NRC's new objectives and organization.

(ii) 'Miles from anywhere - The Story of PRL'

Canada's problems of terrain, climate, isolation, and distance influence R&D activities. The NRC has established two regional laboratories to tackle these problems. The Prairie Regional Laboratory (PRL) was created at Saskatoon in 1948 and given as its first objective the utilization of agricultural surpluses and wastes.[1] These problems were successfully solved technically but not profitably in the then economic climate.

This forced a redefinition of what could be economically successful in the future under prairie conditions. In cooperation with the Canada Department of Agriculture the result of this early 'futures thinking' was the concept of alternative crops, i.e. to reduce unwanted surpluses by giving the farmer an economical choice of crops. This meant a crop or crops different from those then grown, which would be economically competitive, for which a domestic market existed or could be developed by displacing imports, and preferably exportable. The answer was a vegetable oil crop, rapeseed, to replace imported soyabeans and other vegetable oils.

This program was successfully completed by 1961, with

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[1] For example, surplus wheat, cereal straw ⟹ protein and starch, fermented products, and building materials.

a current planting of 3.5 to 5 million acres, several new industrial processing plants, major exports of some $200 million annually, and relatively lower imports of vegetable oils and feedcake. The program survived a major obstacle – the need to reduce erucic acid to levels which would not be prejudicial to human and animal health. By selecting rapeseed strains from all over the world, a low erucic acid strain suitable for the Canadian climate and available growth-time was developed. With the assistance of the federal and provincial departments of agriculture, the prairie universities, and the Saskatchewan Wheat Pool, this is now successfully in production.[1]

The next step was based on 'futures studies' done by others, notably F.A.O.*, on the need for greater world supplies of protein. Suitable northern crops such as peas and Faba beans would be excellent candidates if their protein content could be increased from around 20% to 30%, but this could not be done by the previously used technique of selecting from different strains nor by crossing.

However, another PRL program of research had been going on since 1955 to increase the understanding of how

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[1] 'Cinderella Crop of the 70s?, 'Science Dimension', No. 3, 10-15 (1972); 'Aid to Agriculture of All Nations', ibid, No. 2, 14-16 (1973); 'Visions of Arctic Wheat', ibid, No. 3, 21-23 (1975): 'Rapeseed success story - Rise of a Prairie 'sun' flower', ibid, No. 4, 4-9 (1975).

* Food and Agricultural Organization of the United Nations.

plants grow and what influences their yields. This work showed that plants could be grown from one single cell; that the walls of a single cell could be removed; that the nuclei of two 'naked' cells could be fused (vegetative instead of sexual reproduction) and the cell walls regrown. Armed with these techniques developed over fifteen or so years, the way became clear for the practical development of legume crops with higher protein contents, growable in the prairie provinces.

The work is currently in progress with a forecast target of 1 million acres, crop value in the range of $100-150 million, and a third choice for prairie farmers — cereals, vegetables oils, and, soon, protein crops.[1]

The Prairie Regional Laboratory is thus playing a leading role in Canada's medium- and long-term plans for food and agriculture. These plans will likely be integrated more completely through the interdepartmental activities in respect of R&D on food, referred to in case (i) above, and this integration will in turn provide an opportunity for more complete 'futures studies'.

(iii) The Oldest Technology — Given a New Future

What does one do about the future of the oldest technology in the world?

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[1] The numerous further possibilities are not discussed here, nor the cooperation between the different units in agriculture, industry, government, etc., which are helping bring about these new possibilities.

The NRC's Division of Building Research was formed in 1947 to operate in an industry characterized by fragmentation and susceptibility to the business cycle. Twenty-five years later its performance in meeting the initial difficulties and challenges was analyzed and documented.[1] But in doing this it implicitly set up the question: what next? As its then director said, 'it is now both opportune and imperative to look ahead; opportune since significant advances should now be possible ....., imperative since the nature of the problems ahead continue to change.'

This analysis of the future needs for research for construction for the next ten years had been requested by the President of the NRC in 1972 and was published in 1974 after a long series of consultations with all the 44 national associations directly interested in construction.[2]

The current director has initiated moves to implement this 'futures research study'. The NRC has created the Canadian Committee on Building Research which covers the entire industry, a far from simple move in view of the number, variation between, and inter-relationships of the interest groups involved.

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[1] 'The First 25 Years', Division of Building Research, N.R.C. 13240 (1973).

[2] Hutcheon, N., 'Research for Construction', Special Tech. Publn. No. 2, Division of Building Research, N.R.C. 14005 (1974).

The Committee is sponsoring a series of conferences planned to move the industry ahead in relation to current and future-likely challenges. The first, to be held in October 1976, dealing with 'Energy and Buildings', will be co-sponsored by the professional and trade associations involved, will promote inter-disciplinary participation, and lead to a set of proceedings which will be a guide to the knowledge needed for the design, construction and operation of energy-efficient buildings.

The second impact of the futures research study has been on the program of the Division itself. Three major priorities have been identified: energy research, northern construction, and user needs in buildings.

Since its formation the Division has carried on a program of research related to energy consumption in buildings and this has been accelerated in response to recent demands. Northern engineering work was begun in a modest way in the early days of the Division. With the discovery of oil and gas reserves in the Arctic, the information gathered by this small group became urgently needed. The 'futures studies' of the early Fifties suddenly paid off and in response to the demand the effort in this area has been doubled. Experience in dealing with problems in actual buildings and with technical activities related to the National Building Code has indicated the great need for carrying out research on the user's needs

in buildings. It is recognized that 'buildings are for people' and that research in this area is just as important as technological research. Accordingly, this work has expanded as much as possible under budget limitations, and addresses itself to the question: space for what and for whom?

This brief synopsis illustrates the value of 'futures studies' in reorienting work between the twin poles of needs on the one hand and technical feasibility on the other in relation to desirability.

(iv) Energy from the Wind

In 1968 two members of the NRC's National Aeronautical Establishment began to consider whether developments in low speed aerodynamics could be harnessed to the problem of power generation in developing countries, particularly for irrigation. Using the NRC's then new low speed wind tunnel (originally installed for work on the STOL aircraft), they developed the omni-directional vertical axis windmill with two or three aerodynamically designed vanes. A 15 ft. windmill of this type driven by a 16 mph wind will produce close to one kilowatt of power.[1]

Publication of this result revealed that there were a large number of potential users in Canada, and with the sharp rise in cost of fuel, various departments have since become more seriously interested in the utility of windmills at a time when the first commercial models are

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[1] 'Windmill with No Arms', Science Dimension, No. 5, 22-25 (1972).

just being manufactured by Dominion Aluminum Fabricating Ltd.

More recently, the Department of the Environment found itself in need of reliable weather recording devices for use in the Beaufort Sea area. Bristol Aerospace Company is manufacturing a system based on the NRC windmill with consulting assistance from the University of Manitoba Department of Electrical Engineering regarding the electrical aspects. Encouraged by the Provincial Government, the Manitoba Power and Manitoba Telephone Companies propose to enter this research program as partners to improve power supplies for, and communications to, remote communities served by them. The aim is to lower costs, replace energy imports by wind energy, reduce risk of failure, and improve stability.

A futures-oriented research project originally conceived in terms of a technical capability known in the NRC but needed by others is bearing fruit in Canada, and in doing so, is engendering multi-jurisdictional cooperation, one of Canada's thorniest problems.

This in turn is a sub-set of the interdepartmental program on energy R&D in which the NRC has the responsibility for Task V - Renewable Energy Resources, and for five research areas in energy conservation, fusion, and the use of the use of solar and wind energy.[1]

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1. Task Force on Energy R&D - Exploit Renewable Energy Resources: 'Solar Energy', R&D Program Outline, March, 1975.

   Report of the Task Force on Energy R&D, 'Science and Technology for Canada's Energy Needs', April, 1975.

The setting-up of the interdepartmental framework for R&D will greatly facilitate the ability to use, and to contribute to, 'futures studies' in this area in the future.

Question 17 Work related to 'futures studies' is normally circulated where appropriate to the government departments or agencies concerned, published in the appropriate literature, or issued as an NRC special publication, for example, that on sulphur.[1]

Question 18 No restrictions on the diffusion of 'futures studies' originating in NRC have been noted.

Question 19 The authors, titles, references and brief outlines of 'futures studies', futures-related work and methodological developments are listed in Appendix C.

5. Having responded to the questionnaire, mention must now be made of matters with which the questionnaire does not deal but which are germane to the subject. These are presented under four headings as follows:

(i) The present and inadequate status of 'futures studies'

The present state of 'futures studies' is one of partial development. Some brief comments on this follow:

- the term 'futures studies' is ambiguous as the Swedish

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[1] Vroom, A.H., 'Sulphur Utilization', NRC 12241, Oct., 1971, which made recommendations for organizational means and for research directed to utilizing the accumulating surplus of sulphur in western Canada.

study has pointed out,[1] unless further specified, for example, as to level of generality.

- the definition in question 1 in the questionnaire could refer to future possibilities, i.e. viable options open to government, industry, etc., leading from the present to a future; or it could be applied to the systematic development of utopias or science fiction worlds, e.g. thinking the possible, but not necessarily the probable.

- present methodologies as listed in question 11 penetrate only so far. Writers such as Ross Ashby, Stafford Beer, Hasan Ozbekhan, and Erwin Laszlo probe further into the systems relationships between institutions in real life situations; Eric Trist, Fred Emery and Sir Geoffrey Vickers have outlined the fruitful concept of social ecology; John Kunkel of the University of Western Ontario has examined the behavioral aspects; social scientists such as Suzanne Keller of Princeton University, currently President of the American Sociological Association, have analyzed the strengths and weaknesses of conventional futurism.[2] Futurists, she notes, possess a sense of perspective and direction in their work which sociologists often lack, but they tend to skate over 'the notions of

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[1] Appendix A.

[2] Keller, S., 'The Utility of Sociology for Futurism', Sociology of the Future, Amer. Soc. Assocn., New Orleans, 1972.

system, of patterned interconnections, of collective movements, and of social structure and social disorganization', and the effect of 'social and cultural leadership, or elites on the future'. The Senate Committee has noted the need for advancement of the social sciences. Such advancement and integration with physical, biological and economic sciences is surely no more needed anywhere than in 'futures studies'.

- the definition of 'futures studies' given in question 1 seems to imply a degree of certainty in complex studies, which the detailed simulation modelling work of Forrester, Meadows, Pestel & Mesarovic does not support on the one hand, and which the law of unintended consequences in sociology plainly contradicts (no one can foresee all the consequences of a human action).[1]

- there appears to be confusion between future constraints and future choice. Kahn was right in noting that such matters as G.N.P., G.N.P. per capita, populations, age distributions, labor forces, productivities, available land, supplies of materials and energy, etc. could not suddenly jump or change, in view of the inertia in human systems, the amounts of capital required, the time required to construct facilities and educate workers and management, etc.[2]

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[1] cf. Merton, R.K.'s discussion of manifest and latent functions in his 'Social Theory and Social Structure', Free Press, N.Y., revised edn., 1968.

[2] Kahn, H. and Wiener, A., 'To the Year 2000', MacMillan, N.Y., 1967.

Thus, one can prepare forecasts of constraints numerically by modelling, etc., as the Economic Council does with its econometric Candide model, with due regard to their accuracy. In baseball language this is equivalent to stating the height of the left field fence and its distance from homeplate; it does not tell you, and such information never can, who is pitching or who is at bat, nor even the names of the teams playing. Thus forecasts of constraints are valuable in setting the stage, but they do not tell us who the human players are, or whether they will choose wisely or not. Thus, any view of the future requires a subjective as well as an objective approach. The definition in question 1, however, refers obviously primarily to the objective approach.

- the next point is that the hardest task in looking ahead is to visualize the changes in perception which will occur during, say, the next five years. As the result of our experience with inflation, unemployment, etc., we shall see some things differently but not all. We will perceive the world differently and, since we perceive differently, we shall act differently. This is the chief reason why so much forecasting subsequently appears simplistic and turns out to have been an exercise in the extended present. For this reason, Delphi opinion polls might be right two times out of three for those questions which they ask, but what

of the 40% which they fail to ask at all![1]

There is no 'systematic' way of predicting changes of perception at this time, although behavior pattern analysis is a step in this direction.

(ii) The communication of 'futures studies' to the choosers and deciders.

- The most important, and the hardest, step in 'futures studies' is found from hindsight to be the last – the communicaton of the results to those who requested the studies but who may not have been involved in them. The problems are set out in Appendix B, pages 8-11. These problems are diminished when the entire management is future-conscious; they are at a maximum when 'futures studies' are done by isolated, specialist groups, especially if the leader lacks diplomatic skills.

(iii) The specific relationship, and distance, between a 'futures study' and a research project.

- from what has been said above, it is obvious that there is a long step between the macro-type of 'futures study' on topics such as food, population, etc., which can

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[1] See Gilfillan, S.C., 'A Sociologist looks at Technical Prediction' in Bright, J.R., ed. 'Technological Forecasting for Industry and Government', Prentice-Hall, N.Y., Chapter 1, 3-34 (1968). Cf. also the results of the major U.S. governmental report initiated by W.F. Ogburn in 1947, 'Technological Trends and National Policy', U.S. National Resources Committee, Washington, D.C. The analysis of past forecasts and futures studies is illuminating with its mixture of successes, failures and omissions.

generate hundreds of research projects, and the much smaller number of projects for which resources exist at any point in time. The most dangerous element in this situation is the vulnerability of such longer term research projects to budget-cutting, etc., despite the need to anticipate problems with realistic lead-times.

(iv) The need to involve the general public in studies concerning their future.

- the Swedish study laid particular emphasis on the need to involve the general public in the development of alternative futures. If this is not done, then, in their opinion, the general public would disown privately generated futures. However, the best way to do this is far from clear at present and requires attention.

6. Summing up, the NRC agrees with the need to think ahead and to consider as sensibly as possible the apparent consequences of our decisions and actions before we take them. The arousal of greater 'future-consciousness' seems eminently practical. The NRC believes that 'futures studies' must be conducted integrally with management, and must be made available to the general public.

Usually the NRC is a recipient of the more general type of 'futures study' which is likely to be heavily involved with human, social and cultural considerations. General policy originates with the Minister, Cabinet, Cabinet Committees, etc., in the form of directives,

priorities, budget control, etc. However, as soon as any form of action or action plan is contemplated based on such studies, the NRC is likely to become involved in providing information, validating, generating new information, or combining information of varying degrees of reliability in the scientific, engineering or technical areas. Such involvement will increase in the future, since very few areas of society or of the economy are uninfluenced today by the touch, direct and indirect, of technology and science.

Royal Ministry for Foreign Affairs
in cooperation with the
Secretariat for Future Studies

To Choose a Future

A Basis for Discussion
and Deliberations on Future Studies
in Sweden

APPENDIX A

Foreword to the English version of "To Choose a Future"

The concept of the welfare state has hitherto been seen as closely harnessed to the rapid development of science and technology. However, this development is now also being recognized as a source of danger for our societies because of over-hasty transformations and unforeseen negative side effects. There is broad agreement that scientific and technological capacity will be a crucial factor in our common efforts to bring acceptable material standards of living to all people. But are the present large-scale technologies really furthering this aim? What alternative choices exist? How are cumulative technological innovatory processes to be reconciled with slower changes in social values and institutions? These are the questions to which we ought to devote more attention, if the total development efforts within and between countries are to bring us nearer the all-embracing goal of an improved quality of life for all mankind.

A less naive approach towards the role of science and technology in the promotion of development is emerging. This holds for rich and poor countries alike. An international debate that has been going on for several years has stressed the importance of determined efforts to analyze and "create" the future. The present tendency to know more and more about less and less creates problems for society as a whole; the era of extreme specialization must come to an end.

"To Choose a Future" was produced and published as a contribution to a national and international debate on future problems. The chief aim of the report was to create in Sweden a framework for a continuous dialogue between the general public and their political representatives, the scientific world and interest groups of all kinds. International development in science and technology has been dominated by heavy military and commercial interests. Hence, it is not surprising that most future studies produced so far have also been sponsored by military establishments and by the world's major multinational corporations. Such studies should be the concern of all countries. Critical awareness is needed, as these studies may be based on scales of value that are not democratically acceptable. We must avoid any "colonizing of the future" by powerful interest groups, national or international.

One main idea behind the report is the need for public participation in the work on future studies. We must always devote much energy to making complex problems commonly understandable. Future studies and the discussion about different futures must not be left to a new breed of specialists or to an élite who claim to know what is best for everybody. The democratic control of this work must never weaken, and public participation in vital long-range decisions must be safeguarded and deepened.

International events during the last year have underscored the urgency of the pair of ideas—future-orientation and internationalism—that are basic in "To Choose a Future". I have, however, learned with great satisfaction that international organizations, such as UNESCO and UNITAR, have decided to establish and promote activity in the field of future studies. It is my sincere hope that the international community will extend its responsibility—also in practical terms—to include future generations.

1 Introduction

1.1 Terms of reference for the Working Party

Nationally and internationally, a debate on future studies and future research gained increasing public attention during the 1960's. Within the Swedish administration several discussions on this subject were held by the Government Research Advisory Board. In May 1971 the Swedish Government decided to set up a Working Party to deal with questions of future studies in Sweden.

A communiqué which sheds more detailed light on the intentions was issued on this occasion:[1]

"The Working Party is called upon to explore and evaluate methods and procedures for future studies as well as to compile and evaluate current future research of domestic and above all foreign origin. In addition, the Working Party is asked to assess the manpower situation for Swedish activity in future studies and to investigate which measures can serve to improve and enlarge the education of research workers in this field. For that purpose the Working Party should chiefly consider the staffing and institutional resources that universities and colleges have to offer, but also take up the possibilities that may exist for gaining the participation of other institutions.

"Over and above this assessment of the scientific research position, the domestic research resources available and the educational requirement, the Working Party shall seek to identify problem areas which appear to be especially well suited to Swedish future studies or are thought to be particularly deserving of closer examination. Towards that end various proposals have emerged from the discussions of the Research Advisory Board which preceded the Cabinet's decision. Hence one of the questions that came up has to do with the possibilities a small country like Sweden has to determine its own future in a world of constantly growing influence of the great powers and the multinational companies. Another urgent field for study relates to the work environment problems that may arise in connection with continued technological advance and the ongoing process of structural change in the world of work."

[1] Press release from the Cabinet Office dated May 4, 1971.

At the same time Prime Minister Olof Palme made this statement:[1]

"Future studies are now going on in many places throughout the world. For us in Sweden it is necessary to keep close watch on what is happening here, and to make systematic study of the results that are reached. Many such foreign research projects are directed by military and large-scale industrial interests. It then becomes rather natural to orient the future studies in response to the clients' special wishes. For instance, a great many future studies are concerned with optimizing operational environments for multinational companies in developing countries. This type of study leads up to demands for political stability, guarantees against sudden reversals of trade policy or other abrupt shifts. Such 'future studies' are liable to come into conflict with legitimate aspirations among the majority of people in a developing country to have a say in the shaping of public policy for that country's independent development.

"This last observation needs to be amplified: naturally, one should not conjure up a horror vision of our world as being hopelessly enmeshed in a web spun by malevolent future research. What must be emphasized, however, are the clear risks that arise not only for developing countries but also for small countries like Sweden if future research turns into a sort of uncontrolled monopoly wielded by a handful of especially powerful interest groups. One-sided views of the future contrived in various ways can dangerously call forth a moulding of public opinion as to a certain fatalistic development for countries and peoples, when actually it is the citizens themselves who can and must determine the future development of their society.

"An important and necessary means is that we ourselves will study the future, for us and for our surrounding world, and do so on the basis of democratic objectives and with articulated demands for international solidarity. In that way the small state can create opinion for other possible alternatives as to how the future world should be constituted."

1.2 The interest in future studies

There can be no doubt that a strong interest in future issues and research into long-ranging problems has burgeoned in the past few years. It is therefore appropriate to point out that there is no question of any brand new activity.

[1] Press release from the Cabinet Office dated May 4, 1971.

From a methodological viewpoint one can recognize the successive build-up of forecasts in different areas. One can observe that as soon as an acceptable theory and a data base structured in conformity with that theory are in hand for a particular area, forecasts of the coming development will usually result. Swedish population statistics and demographic forecasts go far back in time. Sectoral and macroeconomic forecasts have become possible thanks to econometric methods and improved national accounts based on these. Many of the hopes that are now pinned on future studies of new subject areas may be realized thanks to improved access to data and more profound theory towards establishing fundamental relationships or correlations.

Considered from a more ideological point of view, the interest in future studies has touched off a renaissance for the societal utopias, bringing with it a heightening of ideological controversies in certain respects. In many cases the future perspective has come to function as a magnifying glass of features and tendencies in the here and now. It is therefore quite natural that the discussion of such basic issues as how individuals can influence crucial government decisions, the problems of ecological balance and the growing inequality in the world society has come to be closely associated with future studies.

1.3 Demarcation and aims

Even a cursory glance at the area of future studies and future research reveals a field of immense and near-unfathomable size, with ramifications that extend to virtually every activity in society. It follows that an investigative effort is bound to be incomplete and severely limited.

In keeping with its guidelines the Working Party for Future Studies has therefore sought to make its necessarily limited contribution put emphasis on providing a reasonable overview of the area and certain general starting points for further, deepened and more detailed deliberations on future studies for different needs in society.

For obvious reasons problems that are common to the whole society, including certain activities in the public sector, have come to occupy the foreground of interest for the Working Party.

No finished proposals for organizational solutions or definite research priorities will be put forward. Conditions in the different needs areas are much too disparate to make any such intentions feasible within the limited time that has been put at our disposal.

As will appear from the problem review made by the Working Party, strengthened future research and increased attention to the

long-term import of many societal problems must be brought about by coordinated decisions in various public bodies (ministries, government agencies, research councils, etc.). As will be elaborated in Chap. 9, the Working Party therefore feels that a broadened discussion—in the form, say, of inviting the submission of comments on this report or preparing agendas for conferences with participation from the research community, interest groups and others—should primarily follow after this first investigative stage. On the basis of such further deliberations (but in some cases even now), it should be feasible to take decisions on concrete measures.

The Working Party's activity, which aims at furnishing an information base on which to rest further debate, deliberations and measures, may be summarized in four points as follows:

1. Attempts to formulate a common frame of reference for deliberations within the future-studies area.

   One reference point for the Working Party's discussion is the connection between future studies on the one hand and, on the other hand, decisions and planning problems with long-range consequences. Depending on the degree of proximity that future studies bear to planning we have divided them into planning inputs, long-term motivated basic research, autonomous future studies, and theory and methodology for planning processes (in a broad sense). Another classification may be arrived at in terms of different aggregation levels (global, international, national, sectoral, etc.). Additional points of departure for further discussion originate in views on democracy and participation in connection with future studies and on the relation between future studies and research policy.

2. Inventory of ongoing future studies, national and international.

   Even though the inventory cannot achieve anywhere near complete coverage or be carried to any particularly great depth, it will probably serve well as a general source of information.

   When it comes to more important Swedish activities, even a relatively fleeting review can presumably fulfil a useful purpose as information communicated between different bodies; it appears as though various planning and investigating agencies are often ill-informed about the methods and contents of past or current research.

3. Exploring needs of future studies for planning purposes.

   The mapping-out process will perforce have to be fairly superficial, considering that the real needs must ultimately be specified by the agency or other party which bears the decision-making and planning responsibility. Even so, an outline picture can suggest opportunities for several such parties to conduct joint future studies. Besides, an outline survey can provide background for discussions of educational needs (Chap. 8) and of research orientation (Chaps. 5 and 7, see also point 4 below).

4. Identification of research needs.

   Bearing in mind the make-up imparted to the Working Party, with its membership consisting mostly of researchers, it is not surprising that this point has come in for special attention (Chaps. 5 and 7 plus the Special Papers). In this context the Working Party has wished to stress that the research efforts shall also be derivable in principle from the needs of planning and the long-run societal structure—though admittedly this can be done no more than indirectly and rather generally where basic research is concerned. In short, the survey and discussion of priorities given in Chaps. 5 and 7 should be continued, and mechanisms should be created step by step which in direct connection with long-range planning processes identify urgent research needs.

2.1 Future studies and society. Some fundamental starting points

A growing awareness that many of the decisions taken today will have very long-ranging consequences makes it increasingly necessary for both the general public and decision-makers to anticipate and take stands on their future responsibility. At the same time it can be noted that certain decisions assume very large-scale or sweeping technical and social effects, and that the pace of changes which directly impinge on individuals is accelerating.

Every discussion of social conditions proceeds, explicitly or implicitly, from certain premises as to how society works and how it ought to work. So does the present review of the knowledge needed to make future assessments, and in this section we shall formulate some fundamental starting points which we consider relevant to Swedish society when seen in a future perspective.

— The future development of society is assumed to take place under democratic control and to move towards goals that are laid down by democratic means.

For various reasons, however, the concept of democracy is of itself problematic in the futuristic context.[1] For one thing, by virtue of planning decisions now being taken, the conditions under which people live are shaped for those not yet entitled to vote, and perhaps even for those who have yet to be born. In many cases there is a real conflict between the short-term interests of those now living and their responsibility to coming generations. In our opinion such conflicts must be brought out in the open. The responsibility for dealing with them must ultimately rest with democratically elected bodies and take place under political responsibility:

— In our democratic society it is a task for the political bodies to represent the interests of coming generations.

[1] Further theoretical and historical aspects are considered in Special Paper S4 (Odén). See list appended at the end of this report.

It is therefore desirable to have the decision-making processes and the organs of government shaped so that they can uphold interests longer-ranging than those of individuals in the immediate moment of decision. But this also assumes that the citizens will have "future awareness" of the kind which enables them to carry this responsibility in the political process and to accept long-term decisions.

To this aspect of "the strong society" can be added the observation that the democratic element of long-range social changes will be confronted with several problems in the real world. In the first place, a great many material and controlling decisions, especially of an economic nature, are taken by bodies which come not at all or only very indirectly under democratic control or which are open to public scrutiny. In the second place, various measures are taken in different sections of the community without sufficient insight into their repercussions on other areas. In the third place, owing to the complexity of many issues popular rule tends to become a mere formality—even in areas where decision-making responsibility rests with democratically elected organs of government. Summing up:

— Future-creating activity must contain the following important elements: a deepening of the democratic process, a greater exchange of information between different actors, and guarantees of participation by citizens in decision-making.

Future studies entail, first, the production and collection of knowledge, and second, the modelling of various kinds of scenarios. But knowledge is power and scenarios have great persuasiveness. Hence the studies here envisioned can become extremely important factors in the power play between different groups in the society. In particular, certain types of statements about the future can acquire an unfortunate self-fulfilling character.

— The democratic state has a special responsibility for bringing out source data on behalf of the long-range public interest and to render service to the weaker groups and individuals, as well as to ensure that free, independent groups also have access to relevant information.

Yet another vital social interest is to make realistic the public dialogue about the future:

— Future studies must identify the real constraints on our prospects for shaping the future, but at the same time present a data base so complete that all favourable prospects can be taken into consideration.

The constraints are of course primarily imposed by the availability of resources, and not least by international circumstances over which we have very little if any control. Further constraints are determined by conflicts between different interests and groups in society as well as by the "legacy" which derives from the inertia and lags in many social mechanisms.

Lastly, it should be said that the most fundamental motive for studying and analyzing remote futures is to enable us to take genuine decisions at the right time, i.e. to shape the future rather than let it be passively shaped for us. But if this is going to make sense there must be more than one alternative from which to choose:

— One of the criteria that all future studies of conditions which can still be influenced must satisfy is to provide for several, *alternative futures.*

This is the only way to guard against the risk that future studies will stand out as descriptions of inevitable and fatalistic events. On the contrary, future studies should give pointers indicating how decisions and measures taken at different points in time can act on the course of events.

2.2 Terminology and taxonomy

Terms such as *future research, futurology* and *Futurologie* are in fairly widespread international use, though no closely specified meaning attaches to any one of them. The word *framtidsforskning* (future research) has been introduced in Sweden, but several good arguments have also been advanced here in favour of a less pretentious label, e.g. *framtidsstudier* (future studies). One compelling reason is that the domain of future studies must accommodate a great many activities which have to do more with the application and development of known methods than with the search after new knowledge. Another is that there can be no justification to have prestige-laden words such as "research" or "science" cover up uncertainty, methodological obscurity and inevitable subjectivity in the making of statements. It is also

possible to discern a risk that linguistic usage will reinforce a tendency to regard future studies as the private preserve of specialists (investigators, planners), thereby eroding the democratic and political element. Lastly, of course, statements about the future pose other epistemological problems than, say, empirical or logical assertions.

Many different principles can be used to structure and classify the domain of future research or future studies. The growing literature in this field certainly contains a profusion of taxonomy. For present purposes we shall refer to no more than a couple of distinctions which seem to be of general interest.

One distinction may be drawn between *passive* and *creative* future studies. Included in the passive category are studies which assume that no major changes can be brought about by one's own decisions. This conclusion may be totally unchallengeable (as in forecasting astronomic events!), plausible for the most part (as in evaluating the conduct of the great powers to provide background for Swedish security policy), but also highly dubious (e.g. certain energy forecasts or population forecasts). A sort of antipole to the passive future studies are the creative ones, whose hallmark is their attempt to identify qualitatively new alternatives, to "invent the future" as it were.

Closely related to creative future studies is the conceptual dyad called *explorative—normative,* a classification that denotes the degree of evaluative direction imparted to the studies: a normative study is governed by a predetermined ideology or vision, whereas an explorative study tries to present different alternatives for the realization of a later value-determined choice (cf. 2.1).

One determination that has played a certain role in the international discussion is the contrast between settled or *establishment* futurology and *critical* futurology. Establishment futurology is portrayed in these texts as sharing a community of interests with a monolithic capitalistic-military power structure, politically conservative and purported to be scientifically "objective" in the positivist tradition. Critical futurology, on the other hand, views the society in conflict perspective (often in terms of class analysis) and concentrates on the feasibility of changes in a radical, anti-technocratic direction.

Yet another factor that distinguishes between different future studies/predictions is the *time scale* or *horizon* they employ. We shall analyze the need of future studies in conjunction with the concept of *planning,* and it may clarify matters at the present stage if we use the classification by time period that is customarily used for planning

purposes. Alongside the immediate planning, e.g. in the form of preparing annual budgets, reference is usually made to two other types of planning: the *medium-term* and the *long-term*. Whereas medium-term planning can be described as prolonged activity planning, admittedly complicated by uncertainty but still based on the same conceptual structure of activities, planning that is going to be called long-term should span across a time period that is long enough to eliminate a great many of the short-term commitments, i.e. so that real decisions can be taken as to qualitatively different activity. For a large manufacturing firm this means that existing machinery and technical know-how will be largely renewable, and in similar situations the "long-term" will take in anywhere from 7 to 10 years. For the Swedish armed forces the time is determined by two factors, the turnover of conscripts and the service life of the most expensive matériel, and it has been deemed that 15 years is a reasonable horizon for long-term planning (see Appendix 1). In respect of physical planning, both as regards the spatial distribution of residents and the location of such things as roads, railways and bridges, considerably longer periods have to be reckoned with, perhaps 40—60 years. The long-term effect of education can, in certain respects, be said to extend across a half-century. Then again, of course, there are social aspects, e.g. as regards values and preferences, where the changes can unfold so rapidly that even 2—3 years may qualify as "long-term" (such that predictions over longer periods can also appear to be quite pointless).

It should be established that the time horizon for *future studies* is equivalent to the definition given here for "long-term": the relative lack of major commitments so that consideration can be given to qualitative changes. It follows from this that the "natural" time horizons for different sectoral and selective future studies will be different.

In the simplified taxonomy that is given here (see 2.3 and 2.4) future studies are classified into (a) "near-applicability" and (b) the aggregation level or sector of the society in which they operate. As will have emerged from the foregoing account, this is not the only possible taxonomy. Nor is it the "best" one, but it is chosen for a definite purpose, which is to provide background for discussions and deliberations on the organization and objectives of future studies in Sweden.

2.3 Different layers of future studies

In this section we shall classify future studies into "layers" on the basis of how close they are to actually being applied. The underlying idea here is to have judgment passed on such studies in the light of their relation to long-ranging *activity* in the society. It may therefore be assumed that a brief description of the innermost layer, planning and long-term activity, will be illuminating (but obviously this does not count as future studies in the proper sense).

Layer 0: Planning and long-term activity

The following principal elements of a planning situation may be distinguished:[1]

an *activity area,* which sometimes lends itself to meaningful division into the *object* to be planned and the body doing the planning (*subject*); an *environment*[2] of the area, which often breaks down into several *subenvironments;* and a *structure of goals and values.*

Planning becomes a problem when major directive measures in the activity area and the effects of these measures occur at moments that are widely spaced out over time. In the time dependence and the inertia that characterize a planning situation, two components may be distinguished: technical and organizational inertia. The basic planning problem is to ensure that the activity being planned can be expected to satisfy certain goals as well as possible in the future environment. As a rule, the description of the future environment is marred by uncertainty. Further, it can be noted that certain subenvironments are noncontrollable, whereas others are amenable in various respects to one's own planning. Another crucial factor, which more formal planning models usually relegate to the background, is the complexity of the planning organization. This often aims at several goals, houses several decision-makers with varying interests and expectations, and can only focus on a small portion of all relevant information. Hence good planning cannot be expected if it draws exclu-

[1] A more detailed presentation in Special Paper S 3 (Ingelstam). See list appended at the end of this report.

[2] In this and many other places in the text the words *environment, environmental* etc. will be used in congruence with the literature on organizations and planning: to designate the world outside the area of activity under consideration. That some misinterpretation may arise from confusion with the more common meaning *ecological environment* is deplorable but probably inevitable.

sively upon decision-making models of narrowly defined rationality (cf. 7.3).

Layer 1: Planning inputs
As used herein, inputs refer to knowledge of the kind that is directly intended for planning purposes. Such knowledge can be structured as in Layer 0: i.e. for description of the planning object, of the environment (or subenvironments), of the goals and values structure. The description embraces a time period beginning with now and leading into the future, and will be more and more marred by uncertainty as it proceeds along this continuum. It follows that the treatment of uncertainty will become a cardinal methodological issue. On general grounds of the public interest, moreover, it must be considered highly important to have the presentation of a data base (inputs) include a proviso which sets out the attendant degree of uncertainty. Provision should be made for alternative descriptions if the uncertainty of goals and/or environments is significant. By the same token, the alternatives available to the planning object (the people that will be affected by the plans) should be spelled out if this is practicable (cf. 2.1).

Layer 2: Target-oriented basic research (see also 2.5)
The reference here is to elements of a fundamental research character which have, or may be expected to have (or ought to have) indirect or long-ranging importance for better planning. Such research needs are normally detected in the course of practical planning which suffers from defective inputs. The term "target-oriented" focuses on precisely this: a general setting of priorities which singles out exigent areas but does not encroach in detail upon strategy or intrascientific quality criteria. A major element of this layer comprises general and structural results in the social sciences, which often provide a more relevant information base than future research in a more limited sense.

Layer 3: Autonomous future studies
Subsumed under this category are all future-studies activities of the kind which are not governed or should not be governed, whether directly or indirectly, by the needs of existing planning. Important elements of the autonomous future studies are:

Large parts of (in one sense nearly all) autonomous basic research (see 2.5)
Critical research and counter-planning

Research and planning ethics
Non-established groups' future studies
Futuristic journalism
Literary, political and religious utopias/dystopias.

Layer ω ("metalevel"): Studies about planning and future studies
Classified hereunder are different kinds of planning methods, forecasting methods, planning theory, organization and innovation theory, theory of science applied to future research, etc.

2.4 Aggregation levels in future studies

Another principle of classification (which is explanatory in some contexts) is the "aggregation level" at which society is being studied. Obviously, the intention is not to create a comprehensive taxonomy but merely a suitable array of reference concepts. With geographic magnitudes taken as basic, the following hierarchy of levels may be used:

global (without regard to national boundaries)
international (with regard to national boundaries)
national
regional
local
household
individual

However, firms which cater to markets both in Sweden and abroad can scarcely be fitted into any of the foregoing: theoretically, such a firm may be found at all of the upper levels.

In addition to this classification a distinction may be drawn as regards breadth of the activity area, at least between studies that have a *total* ambition, those that are clearly *sectoral* or bear reference to even more sharply marked off activities, exceptional raw materials or products. (A third classification principle is by *time scale*, see 2.2).

For example, the MIT (Massachusetts Institute of Technology) study called "The Limits to Growth" (see 3.2) is global and imbued with a kind of total ambition, whereas some of FAO's investigations can be regarded as global studies of sectors (in this case agriculture). In Sweden, for example, defence planning (Appendix 1) is geographically national and operationally sectoral.

The levels here described may be used to classify users (decision-makers, planning subjects) as well as studies (planning inputs).

In line with a characteristic that is more or less universal, a user/planning officer at any one level will usually need inputs from the level above his own level and the one below him.

2.5 Future studies and research structure

It follows from the definitions given above that future studies in their entirety are not research in the established sense, nor can all research be regarded as future studies: future studies do not constitute a subset of research and do not contain this as a subset. On the other hand there are a number of important linkages between future-studies problems and research policy, of which a few will be touched upon below.

Research structure

One distinction that looks fruitful in a discourse on research structure is that between *applied research* and *basic research*. (For our present purposes we shall disregard the concept of *development work*, which is commonly bound up with research as "R & D".) Applied research chiefly aims at satisfying certain needs or solving certain (extrascientific) problems. For this reason applied research can be assigned to a specific activity area, or perhaps to a handful of areas. The crux of whether or not to undertake applied research of a certain kind is the *benefit* it can be assumed to confer on the activity.

By basic research, on the other hand, we mean research of the kind that does not stem from connections with a special activity, but which works on problems that are considered "intrinsically" interesting and where the utilitarian aspect plays a secondary role. From the vantage point of the user and the larger society, yet another distinction within basic research may be of significance.

Target-oriented basic research refers to basic research which has, or may be assumed to have, special importance in any subsequent application.

Autonomous basic research, by contrast, is not conducted with any explicit benefits in mind but is solely prompted by motives such as scientific curiosity, general cultural significance, intrascientific topical value, the pursuit of a tradition, etc.

The distinction between target-oriented and autonomous basic research does not lie in methods or quality criteria, nor primarily in the investigator's own motivation for carrying out his project, but in those motives that prevail on a client/donor to support the project.

If we divide scientific activity along two lines, the first according to method or theory, the second according to application (if one can see any), the basic research project may be said to orient itself to methodological or theoretical aspects (which for each special method, theory or discipline can yield many applications), whereas the applied research project will of course orient itself to the application (where for any one application several disciplines may be brought in).

Without venturing to go into knotty and possibly controversial issues as to the connection between research and public policy, we can establish that the view of applied research in these words—"it must primarily proceed on the basis of each area's conditions and problems"—probably commands a wide consensus. By definition, the same thing can be said of target-oriented basic research, but with the important addendum that basic research in general is long-term by its very nature, i.e. it cannot be expected to furnish contributions to any concrete activity until after a fairly long time has elapsed.

Linkages

Turning to the basic concepts we introduced in 2.2, it can now be noted (with all the reservations that must attach to such relatively imprecise terms) that the production of planning inputs (Layer 1) naturally embraces applied research, but also a great deal else besides. Planning-motivated basic research (Layer 2) should be seen as one part of target-oriented basic research, with the addendum that essential knowledge needs for the future will presumably require interdisciplinary effort at the basic research level, and to a greater extent than for target-oriented basic research in general. One way to orient research is to have each activity area go in for long-term planning, a central aspect to which we shall return (4.8, 5.1).

In respect of the knowledge needed within theory and methodology (the metalevel, Layer ω), we can identify fundamental as well as applied research, not to mention a great deal more that bears the character of development work (see Chap. 7).

A strong dependence between different layers and generally between research, future studies and development work is defined by the availability of research personnel and specialized experts. The Working Party will return to the questions of competence and education in Chap. 8.

The members of the research community—acting as enlighteners,

Cassandras, zealots and so forth—have played an important role in the autonomous future studies so far, and there is good reason why this state of affairs should be encouraged. Thus it will be essential to develop good contacts between the universities, other facilities for adult education, and the mass media (cf. 6.2).

The interdisciplinary aspect

Yet another essential is the cross-fertilization of disciplines that must permeate most activities in the future-studies area. Some of the consequences flowing from this can be singled out. It will be necessary to communicate across subject boundaries, an element that must be provided for in the official curricula. However, this is not a matter of dissolving existing areas of specialization and methodology—and replacing them with futurology—but rather of an interaction in which every subject can contribute the best of its knowledge and know-how. Future research has been spoken of as a "synthesizing science" in contrast to the traditional "analytical sciences". Any claims to monopoly coming from one or more existing academic disciplines must be rejected. Properly handled, the mooring of research in a future perspective can catalyze an interdisciplinary approach.

2.6 Goals, decisions and values

It is fairly easy to agree, on a general level, that "development should be directed towards politically established goals" and the like. But in daily practice it seems extremely difficult to obtain a solid, concrete description as to what constitutes the "goal" for any one activity. This is indeed a formidable problem, and without going into details we can observe that various attempts to formulate a logically unassailable definition of "goal" have been less convincing than similar efforts to define such terms as "decisions", "values" and "preferences".[1] Hence there may be good reason for using the concept of goal with a certain degree of caution.

The Working Party accordingly does not propose to solve the conceptual problems concerning goals/decisions/values, but will instead present some viewpoints which are deemed to have relevance for long-term activity and future studies:

— Establishing goals is essentially a political question.
— Assessments of the state of knowledge and development potential are crucial to the formulation of realistic long-term goals for an activity. Hence certain types of information about the future must enter into the determination of goals, but on the other hand it cannot replace the normative, political element.
— In many types of long-term activity it is both useful and reasonable, as the results of an activity gradually unfold, to reappraise and if necessary adapt the goals to results attained and resources available.[1]
— The derivation of goals for any one activity from "goals on a higher level" can seldom be made altogether conclusive. Attention must therefore be called to the leeway for subjective values and political judgment when goals are "broken down".
— Increased attention to the "decision-making environment", i.e. the formal and informal organization in which different decisions are in fact taken, would appear to be well justified both on theoretical and practical grounds.
— In the most interesting cases, the structure of values and goals contains several goals; this may be dictated by the interests of different actors as well as by "objective" factors. Planning models must be sought which take the resulting goal and interest conflicts seriously (see also Chap. 7).
— In respect of activities which lack feedbacks (in the form of market mechanisms or the like) or give insufficient information, a strong case can be argued for the development of methods to evaluate goal fulfilment and effectiveness over time and especially in the long run.

One fundamental problem of immense scope is the relationship of long-term planning to those changes in goals, values and preferences which may occur during the future period covered by planning. Some main types of ways and means to deal with this problem may be distinguished:

1. To assume, explicitly or implicitly, that present goals and values will also hold for the future.
2. To plan for the deliberate steering of values in a certain direction ("manipulative" planning).

[1] See also Special Papers S 4 (Odén), section 1.2 and S 3 (Ingelstam), section 5.

[1] A conscious process of adaptable evaluation and goals revision is especially warranted in connection with large-scale public measures having long-term effects. This is also discussed in Chaps. 4 and 7.

3. To anticipate how the values will be changed and adapt the planning accordingly.
4. To build room to maneuver into the planning process so that it can accommodate changed values in the future.

It follows that a better understanding of how values change and how such changes find expression in planning decisions takes on central importance in the future-studies picture (see also Chap. 5 and Special Paper S 4, Odén).

2.7 Legitimacy, candour and democratic control

The general starting points for future studies and the democratic society that were given in 2.1 can now be made more specific.

In principle, the studies that are supposed to provide planning inputs (Layer 1) go directly into the planning process (Layer 0). In other words, democratic legitimation cannot be divorced from that which holds for the planning itself. When the matter is one of planning for a public activity controlled by democratic means, all criteria of justice can be said to be met as such. On this other hand the cumbersome nature of planning harbours a danger of rule by experts and elites. Strong and deliberately shaped democratic controls will have to be built into the system in many cases. In respect of planning objects outside direct public control, such as business firms, a high standard of public scrutiny and powerful directive instruments will have to be brought into play whenever vital national interests are affected, such as in the implementation of regional development policy or manpower policy.

Studies of a basic research character (Layer 2) have several addressees: applied research planners (Layer 1), the scientific community and the body politic. The cardinal criterion for maintaining candour and democratic criticism is to demand full disclosure of all results.[1]

The autonomous future studies generally aim at both the scientific community and the general public, and as such intrinsically contain a democratic-critical component. To maintain a broad spectrum of views and opinions is of vital public interest, which should be considered as primarily belonging to the sphere of cultural policy.

Lastly under the heading of methodology and theory (Layer ω), we should like to add but one reflexion: generally speaking the values implicit in planning and investigative methodology are not so neutral as is often imagined. The methods used in a study can steer the results in a certain direction, even when this is not intended by the investigators themselves, and can do so to a much greater extent than generally worded postulates or terms of reference. In particular, certain types of methodology based on easy-to-grasp numerical data show a tendency to "take charge" much too quickly, so that an independent and factual analysis of what the problem actually looks like never comes into being. Coming to grips with this state of affairs would appear to be a major task for "critical" research into methodology (see also Chaps. 7 and 8).

[1] Unfortunately, it must be said that the mechanisms of information dissemination are inadequate, and certain tendencies are clearly disturbing: the unpublished scientific literature, in the form of institutional reports and the like ("fugitive literature"), keeps growing while the periodicals lag behind. The difficulties of obtaining up-to-date results pose both scientific and democratic dilemmas.

THE NATURE OF FUTURES PROBLEMS

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We do not yet possess an adequate statement of the nature of futures problems, but recent progress suggests that we are now in a position to attempt this. The present paper seeks to do this in terms of their definability, the probabilities involved, measurability, and the communicability of results.

The analysis suggests that the methods used in forecasting are in effect attempts to reduce the unlimited possibilities in future situations to manageable proportions.

A better definition of future problems should clarify what can and what cannot reasonably be expected in this field between futurists, forecasters and planners and their clients.

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THE NATURE OF FUTURES PROBLEMS

FORMAT

THE NATURE OF FUTURES PROBLEMS

INTRODUCTION

One of the weaknesses of futures studies is that their basis has never been properly articulated and defined. We see, therefore, a proliferation of methodologies, the relationships between which are not immediately clear, and a tendency for one method to be championed by an exponent, a consulting company, or a group of experts. In practice, the results are all too frequently that, when a company, government department, or other institution decides to look at its future, the emphasis falls on the methodology/methodologies to be used,[1] or on the selection of a particular futurist and his organization! Some time and many dollars later it finds itself chagrined at having spent so much effort for apparently so little in the way of the concrete results it expected. The time for this cycle in industry has been approximately three years, after which management reorganizes or abolishes its futures efforts for the time being.

Thus, at some point in time, the futures movement must put its house into better order. This means a more disciplined formulation of what it is and what it can reasonably attempt to do. One step in this direction is to establish the nature of problems which, by definition, deal with events that have not yet happened. How do such problems differ from conventional problems? and given the differences, what can we do about them? It is the purpose of this paper to attempt this in the light of recent developments in several related areas.

ILL-STRUCTURED VS WELL-STRUCTURED PROBLEMS

The starting point is the degree of structure in the problem. Thus problems of the past and the present, and those which can be handled by the methods of normal science fall into the category of well-structured problems. Problems in such areas as the social sciences are characterized by many variables, many interactions, and qualitative and holistic aspects. Futures problems are similar, with the added complication that the number of possibilities becomes astronomical as the time frame is extended. The latter two categories constitute ill-structured problems.

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[1]Examples of the single methodology approach include Delphi, Honeywell's PATTERN, TRW's PROBE, etc.

These differences can be set out in terms of four characteristics of problems:

(i) their definability

(ii) the probability relationships involved

(iii) their measurability, and

(iv) the communicability of results

as shown in Figure 1.

MAJOR CHARACTERISTICS	- PROBLEM - WELL-STRUCTURED [1]	ILL-STRUCTURED [2]
DEFINABILITY	--->100%	<< 100%
PROBABILITY RELATIONSHIPS	$p + q = 1$	$p' + q' \neq 1$
MEASURABILITY	$h\nu$ [3]	V(S) = P.E.V. [4]
COMMUNICABILITY	--->100%	<< 100%

[1] Typically, past, present problems; normal science

[2] Typically, social science, futures problems

[3] Limit set by the physical uncertainty principle

[4] The mathematics of purposive action

FIGURE 1 - CHARACTERISTICS OF WELL-STRUCTURED AND ILL-STRUCTURED PROBLEMS

1. Definability

Well-structured problems are completely definable; they are either posed in this form as in theoretical treatments, or they can be put into this form by the extension of the existing paradigm or through agreement between experts/participants to the problem. The latter course is of major importance in applied science and engineering, where de Solla Price's 'college of cardinals' mechanism exists to validate that the problem is agreed to be this, and not that. This is equally true in business where management, or unit managers, agree to define a technical, production, or marketing problem for the current time frame within certain limits.

Under these circumstances the underlying assumptions are explicit, usually expressible in mathematical form, and the treatment is objective. The next generation of scientists, engineers, managers, etc., is trained to deal with problems in this manner. An on-going, self-propagating, adaptive chain of people is thus created, who maintain the system by means of appropriate values, beliefs, rewards and myths.[1]

The case of the ill-structured problem is very different. Each person views such problems from his own point of view and, as shown later, defines them differently since they 'see' them differently. There is no commonly agreed set of assumptions. What one person regards as a serious, even cataclysmic problem, may be seen as merely trivial by another, with many shades of opinion in between. Nor can these differences be papered over by agreement between experts owing to the occurrence of what Hasan Ozbekhan calls interventions[2] and insurance companies acts of God. Volcanoes can blow up, islands do appear and disappear into the sea, droughts and floods do happen, new viruses and bacteria may appear from 'nowhere', an atom bomb may explode. To pretend to define the future explicitly is to exclude the

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[1]See Mulkay, M.J., "Conformity and Innovation in Science," Sociological Rev. Monograph, 18, 5-23 (1972) for a review of such mechanisms in the field of natural science; also "Problem Areas and Research Networks in Science," Sociology, 9, #2, 187-203 (1975).

[2]Ozbekhan, H., "The Emerging Methodology of Planning," Fields within Fields, #10, Winter, 63-80 (1973-4).

very element which gives it its chief characteristic - its unknowability.

Fortunately, the problem of *definability* has been clarified by the work of Mitroff and Turoff.[1] Using the mathematics of the Ackoff school,[2] they have shown that there are third and fourth sources of statistical error arising from the inability to define futures problems precisely. The well-known first and second sources of statistical error (rejecting the null hypothesis when true - E_I; accepting the null hypothesis when false - E_{II}) assume that the problem has been 'correctly' defined, which is only possible for well-structured problems. For ill-structured problems this is exactly what is in doubt, and Mitroff and Turoff demonstrate the finite possibility of solving the wrong problem - E_{III} and E_{IV}.[1] Thus the crucial element in all futures work is: *have you posed the 'right' question(s)?*

Even this is not as simple as it sounds. How does one determine what the 'right' question is, and when does one do this? X months or years after a decision has been taken, it may be possible to say that the decision was 'right'; but (X + Y) years later this may no longer be true. The manufacturers of buggy whips were 'right' for years, but X proved to be a finite number and their business largely faded away. Railroad companies held similar beliefs and in our own time many aerospace companies. One of the most common examples is probably the cyclical reevaluation of merit (or variation in taste) in literature, music and art. The history of putting a man on the moon may follow a similar course.

The reason for this is that, in futures problems, we are dealing with a multiple, feed-forward, feed-back system, as shown schematically in Figure 2.[3]

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[1]Mitroff, I.I. and Turoff, M., "On Measuring the Conceptual Errors in Large Scale Social Experiments: The Future as Decision," Tech. Fore. and Social Change, 6, 389-402 (1974).

[2]Ackoff, R.L. and Emery, F.E., "On Purposeful Systems," Aldine, N.Y. 1972.

[3]Beer, Stafford, "The Brain of the Firm," Allen, The Penguin Press, London, 1972; Forester, Jay, "Principles of Systems," Wright-Allen, 1968, etc.

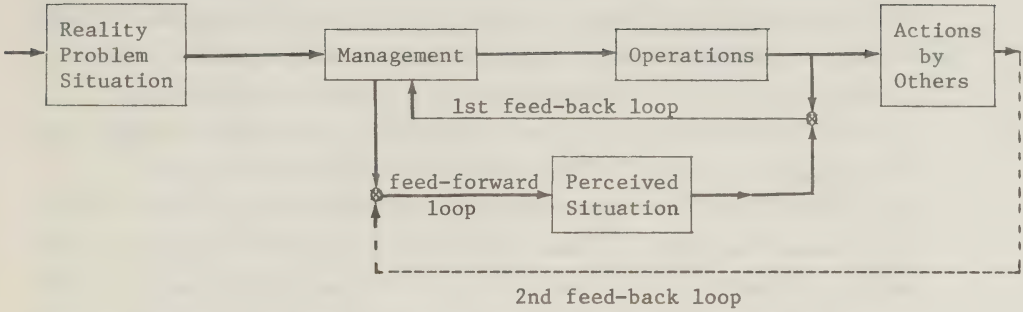

FIG. 2 - SCHEMATIC FEED-FORWARD, FEED-BACK LOOP SITUATION

Since the decision to be taken concerns events which have not yet taken place, a conceptual model is constructed of what is currently thought (perceived) to be the future situation; or in other words, the organization sets up an implicit, or explicit, feed-forward loop. Having constructed what it believes to be reality, the organization defines the 'right' questions to be posed under these circumstances and then makes its decision in terms of these questions. Since it is not certain whether it has defined the problem correctly nor whether it has made the 'best' decision, it sets up feed-back loops to monitor the results of its own operations and those of its customers or clients. The feedback of information on results may modify or confirm management's perception of the situation, and we have an on-going, but not necessarily repetitive system. However, such systems will oscillate or hunt unless suitably damped. Management is thus constantly faced with the need to strike the balance between too tight a control and reduced sensitivity in its feed-forward, feed-back decision/monitoring loops, which filters out vital pieces of information, or too lax a control which can give rise to oscillations and ultimately collapse. In real life, management also has the problems of cross-interaction between different loops (different activities). Thus, it is not sufficient just to recognize

that one can choose and solve the wrong problem. We are in fact constantly making our choices on the basis of what the psychologists term a *gestalt*, or whole view of the situation. This is peculiar to ourselves, or, with adequate planning, to the organization or unit, may change with time and experience, and may or may not be agreed to by others.[1]

Thus, the perception of a business by those in charge plays a critical role in determining what problems are considered 'right' and therefore which decisions are actually taken.[2] The significance of this will be referred to later on. The question of definability does, however, affect statements about probabilities very considerably.

2. Probabilities

One of the characteristics of normal science is that, for any event A, the probability of the complementary event "not-A" is 1 minus the probability of A.[3] This statement represents what we mean by a fully defined situation; and a problem becomes well-structured as and when the limits placed on it enable such a probability statement to be made in reference to it.

In futures work this is exactly what is not true. The situation is no longer completely definable. We are therefore confronted by probabilities which cannot be completely stated. It may still be helpful to define such probabilities while admitting some elements have been left out. But if so, the two probabilities must be calculated separately, i.e.:

$$p' + q' \neq 1 .$$

A further point is that the two probabilities, p' and q', do not refer to the same kind of thing. In industrial situations, the criteria for success may well be technical, financial and marketing; the criteria for failure in such projects have turned out subsequently

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[1] See, for example, Gastil, R.D., "A General Framework for Social Science," Policy Sciences, 3, #4, 385-403 (1972); Jantsch, E., "Forecasting and the Systems Approach: A Critical Survey," ibid, 475-498.

[2] Simmonds, W.H.C., "Towards an Analytical Industry Classification," Tech. Fore. and Social Change, 4, 375-385 (1973).

[3] For example, Hays, W.L., "Statistics," Holt, Rinehart, N.Y., 1963.

to depend on *totally different* things, for example, noise effects (the SST), safety (nuclear reactors), aesthetics (power line location), wild-life and nature preservation (the San Francisco Bay area), eco-destruction (upper atmosphere effects), etc.; or such projects may simply afford the opportunity for the venting of alienation and frustration against 'impersonal institutions' (anti-fluoridation campaigns, environmental movements, earth-preservation projects, etc., etc.).

For ill-structured problems such as those in the social sciences and futures, the probabilities for success and for failure must always be calculated separately since the success and failure modes differ. Only when the problem is made well-structured, do the two kinds of probability come together and become the same.

This is profoundly important for governments to understand. The 'success' of political progress is frequently predicted in terms of short-term cost-benefits, while subsequent events have revealed the unintended consequences of these programs in the form of high human, social and environmental costs.

3. Measurability

(i) The first uncertainly principle.

The first uncertainty principle refers to the effect of the act of measurement on a system in which the entities in it are not changed by the measurement itself - the Heisenberg-Schrödinger physical uncertainty principle.

The implications of this kind of uncertainty have been thoroughly worked out by physical scientists.

(ii) The second uncertainty princple.

The second uncertainty principle states that, where the entities in the system to be measured are animate, the act of measurement affects both the measurer(s) and the measured.

To the writer's knowledge, this principle has not yet been set out in mathematical form; it would presumably require the purposive-purposeful type of mathematics described below.

The second uncertainty princple is profoundly important in the *discipline* of ill-structured problems. It sets the limits of knowledge and the ability to find out as definitely as the first

uncertainty principle sets the limits of knowledge in physical systems, where the act of measurement requires interaction by the measurer with the system and in so doing perturbs it. This perturbation prevents the mechanical calculation of the future of the system because its condition at any one point in time can *never* be completely specified in terms of velocities and momenta.[1] Correspondingly, the 'state' of a human being or group of human beings (society) cannot be measured at any one instant and therefore cannot be projected deterministically; but the situation is worse, since any act of measurement alters the probabilities in the set of future possible states - the well-known self-fulfilling prophecy aspect of forecasting.

T.P. Wilson has, however, clarified the situation in the field of social psychology by comparing the normative and interpretive paradigms regarding the interaction of two or more actors.[2] In the normative paradigm, actors are assumed to share a system of culturally-established symbols and their meanings, including language and gestures. They interact in terms of their dispositions and role expectations, role conflict, conformity and deviance, and sanctioning or reinforcement processes. For stability in any exchange, the actors must refer to the shared system of meanings of the group within which the interaction takes place. If they do not do this, there is no way *for an observer* to decide whether two behaviors, performed by different actors or the same actor at different times, are repetitions of the same action or represent totally different actions. The normative paradigm therefore implies that each actor always knows what role the other is taking. Given this, an objective description of the interaction can be made, provided that the observer has learnt the culture of the group he is observing.

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[1]The Victorian billiard ball approach. If only we could measure all the positions and velocities of all the balls at one point in time, we could then predict -----. This paraphases to: if only we could measure all the physical and mental states of all members of society at one point in time, then we could -----. In Laplace's language the future programs of the whole universe should be calculable, given its state at one instant, which is, of course, precisely what can never be measured. See Ashby, Ross, "Design for a Brain," Chapman & Hall, London, 2nd Edn., 1960, p. 28.

[2]Wilson, T.P., "Conceptions of Interaction and Forms of Sociological Explanation," Amer. Soc. Rev., 35, #4, 697-710 (1970), where he presents the complete argument.

The interpretive analysis rests precisely on the point that *alter* can never really know what role *ego* is taking at any point in the interaction, and must constantly search for verbal and non-verbal clues to see if he has changed his role. Consequently, the perceived purpose and meaning in the other's actions are always provisional and subject to revision in the light of subsequent events in the course of the interaction. The *role-expectation* approach assumes that the roles are known and continue to be known to both parties throughout the interaction; the *role-taking* approach rests on the well-known fact that we never know what is going on in somebody else's mind, and can only infer this from the clues which they give us, from our own experience, and from the general cultural background and situation. Uncertainty is therefore inherent in human interactions, and interest shifts from the act of measurement to the process of measurement and its influence.[1]

It is apparent from the above brief presentation that much of the current discussion in the social sciences concerning their basic paradigms[2] is closely related to this discussion of the nature of futures problems, since both deal with ill-structured problems.

(iii) Futures Mathematics.

The difficulty in defining 'right' problems discussed above makes it clear that conventional, value-free, mathematics is not likely to be fully adequate in the analysis and synthesis of ill-structured problems and situations. Since we cannot describe futures problems without reference to a *gestalt* or whole view of the situation as seen by someone or some group, we are in the position of imposing our value-structure in the act of choice of problem. "This' is more important than 'that'; therefore we will look at 'this'. Subsequent events may or may not justify the choice, or we may manipulate them to try to justify our choices; but we cannot make a value-free choice in regard

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[1]See the discussion of measurements in the field of fertility given by L.L. Bumpass and E.D. Driver in reviews of A.V. Cicourel's book, "Theory and Method in a Study of Argentine Fertility," John Wiley, N.Y. (1974) in Contemporary Sociology, 4, #5, 474-481 (1975).

[2]See, for example, Ritzer, G., "Sociology: A Multiple Paradigm Science," The Amer. Sociologist, 10 (August), 156-167 (1975).

to futures problems. We could choose them at random, or accept other people's *appreciation* of the situation;[1] or we may simply extend the present and dodge the issue that way. Since human institutions display the phenomenon of inertia and resistance to change,[2] this is usually felt to be reasonable for short time periods.

Fortunately, the Pennsylvania school of Ackoff, Churchman, Emery and Trist has struggled with this problem for some thirty years and produced a mathematics for purposeful systems.[3] Mitroff and Turoff used this mathematics to establish the third source of statistical error, E_{III}- solving the wrong problem. It is reasonable to expect that this approach will become better known and further developed as the characteristics of futures problems become more widely realised.

James Coleman has developed a somewhat different approach.[4] He notes that this kind of action theory "provides an economy that allows it to make predictions with a less extensive data base than is true for causal theories." We shall pick this point up in connection with behavior patterns and their value for futures work.

On the basis of this discussion, a major step forward should occur when the second uncertainty principle can be expressed in terms of a 'new' mathematics.

4. Communicability

After we have defined what we believe to be the 'right' problem or group of problems, and made measurements with due regard to the uncertainty principles involved, we still face the problem of communicating the results to our colleagues or to those who have commissioned

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[1]Vickers, Sir Geoffrey, "The Art of Judgment. A Study of Policy Making," Methuen, London, 1965.

[2]Michael, Donald N., "Planning to Learn and Learning to Plan;" Trist, E., "Resistance to Innovation - Human and Organizational," Innovation Canada, Proceedings of the Fourth Seminar, 1974, obtainable from Innovation Canada, 533 Arbor Road, Mississauga, Ont. Canada.

[3]Ackoff, R.L. and Emery, F.E., "On Purposeful Systems," Aldine, N.Y., 1972.

[4]Coleman, James, "The Mathematics of Collective Action," Aldine, N.Y. 1973.

the studies. It appears to be a universal experience in futures work that this, the last step in the chain, is systematically and regularly underestimated! The reasons are not far to seek. The boss naturally assumes that his higher position in the organization implies better judgment on his part[1] and greater ability to achieve[2] than is possessed by those working for him. On what grounds then can someone junior proffer advice which recommends that his boss do something different from what he originally intended, in regard to events which have not yet happened?

(i) The 'Futuror' and his credibility

The 'futuror' (futurist, forecaster, planner) must establish his credibility opposite management or his client in areas where they can judge him, i.e. in terms of their *current* problems. This is where the hard work comes in, since this kind of credibility can only be gained and maintained by a better, deeper understanding of these problems than the current 'wisdom'. However, once such credibility has been established, management has a basis on which to refer *future* problems to the 'futurors'.

A major element in credibility is clearly the ability to discern what turn out later to be the 'right' questions in, for most organizations, the short-term. Given agreement on what constitute the 'right' questions, numerical forecasts can be generated and tested on the basis of varying assumptions. This is best left to those who normally provide such data. It is easy to be out by several hundred percent numerically,[3] but only by 100% (right or wrong) in the choice of questions to be asked!

(ii) The 'Futuror'

Credibility cannot be established without a relation-interaction between the 'futuror' and the 'futuree', his client. We have

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[1]Simmonds, W.H.C., "How to Make Sure You Have a Future," Innovation Twelve, 36-43 (1970).

[2]Christopher, W.F., "The Achieving Enterprise," Amer. Manag. Assoc., N.Y., 1974.

[3]Hindsight and the analysis of past forecasts.

noted that assumptions regarding ill-structured problems cannot be simply explicated. Thus the possibilities for misunderstandings in setting up a futures study, during the study, and in the reporting of the study are real and serious. They must be circumvented by ensuring that management or the client is involved in, made part of, the study, from its conception, definition of scope, conduct, right through to the final report and recommendations. The client must set limits to the scope; he should contribute certain information appropriate to his position; he must never be allowed to disengage under excuses of pressures of work; he should review progress and suggest improvements; his advice concerning recommendations and conclusions is crucial if he is going to implement them. At no point under these conditions can he disown the study, nor is he likely to do so if he has contributed to it.

Thus 'futurors' must '*thread*' futures studies into an organization so that the studies become the organization's. In addition, each level of management involved in these studies must '*hook on*' to the next level and to adjacent areas of management to ensure the upward momentum of the study and its results, if these are to have any real impact on events. The saddest sight in the futures world is the report lying on a shelf unused, whether incomplete, unedited or beautifully bound. The last step in the futures chain is the hardest, to convince someone else that one's findings are valid, useful, and worth acting on.

(iii) The Characteristics of 'Futurors' and 'Futurees'.

Since values and beliefs enter into the choice of futures problems, the personal philosophies of the 'futuror' and his 'futuree' and their inter-relationships become important. Mitroff and Turoff have set these out as Leibnizian, Lockean, Kantian, Hegelian, and Singerian in terms of inquiring systems, and applied this thinking to specific cases.[1]

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[1]Mitroff, I.I. & Toroff, M., "Technological Forecasting and Assessment: Science and/or Mythology," Tech. Fore. & Soc. Change, 5, #2, 113-134 (1973); "A Case Study of Assessment Applied to the "Cashless Society" Concept," ibid. 7, #3, 317-325 (1975).

Harold Linstone has noted that the differences between 'futuror' and 'futuree' could also be expressed as a difference in discount rates. He has already noted the pervasive tendency to discount the future, a fact largely ignored by the Club of Rome's modellists.[1] What seems important here is that there is a *differential* discount rate between the 'futuror' and the 'futuree', and that this offers a way of treating this difference as noise introduced into a communication process, i.e. a potential link between futures work and communication/information theory. In practice, line managers have a three months' time frame (one business quarter), presidents one year, politicians one election, all of which are extremely short in real terms; even a 5 year planning time frame implies a discount rate approaching 50%. The only realistic long term discounter appears to be a girl assessing a proposal of marriage. Her 'yes' is based on something close to a 5% discount rate, longer, one guesses, than that of her erstwhile future husband!

This raises the questions: do different 'philosophers' have different discount rates? How do the different philosophical attitudes interact in hierarchical organizations (is this the origin of Professor Parkinson's famous yes-no alternation in hierarchies)? Can communication theory be extended along these lines to take account of differences in the characteristics of human receivers and senders, etc. etc.?

Linstone has made a start in this direction with his paradigm of futurists as discounters, extrapolators, goal setters or cyberneticists. Can we go further?

(iv) Constraints and Choice.

There appears to be a continuing confusion between constraints and choice. Thus predictions of G.N.P., G.N.P/capita, total population, population by age group, regional distributions, etc., are in effect constraints. As Kahn and Wiener pointed out,[2] India's per capita G.N.P. cannot equal that of Japan overnight. These constraints can be compared in baseball language, to the physical size of a ball park, the height and distance of the left field fence, the distance between bases, etc.

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[1]Linstone, H., Review of the Mesarovic-Pestel Club of Rome II Report, Tech. Fore. & Soc. Change, 7, #4, 331-4 (1975). Also "On Discounting the Future," ibid. 4, #4, 335-8 (1973).

[2]Kahn, H. and Wiener, A., "The Year 2000," Macmillan, N.Y., 1967.

But note that they tell us nothing about who is at bat or who is pitching. Thus, the evaluation of the probable G.N.P., population, etc., does not tell us what human beings, groups and institutions will decide to do, wisely or less wisely, under those circumstances.[1] Such choices are made in terms of the perception of the situation by the decision makers. Our perceptions of what is significant or important change with time. A good example of this was the change in the American perspective on the Viet Nam war over a decade. The hardest part of forecasting is therefore: how will I (or management) see (perceive) the world in five.... ten years time? One of the valid criticisms of some forecasting methods is that this is not included or explicated. The key weakness in Delphi has always been that certain questions were *not* asked; they did not seem important when the study was started. Later we know better! The analysis of what causes us to change our perceptions of the world in which we live is therefore one of the most important elements in forecasting.

(v) The results.

Before communicating, futures results should be evaluated, as Joe Martino has pointed out, for need; underlying cause; relevance; and reliability.[2] These checks reduce the likelihood of an elementary error or omission from slipping through by a systematic interrogation of the work and results. Martino has given an excellent description of this and there is no need to repeat it further.

The above shows that the successful forecaster, long-range planner or futures worker not only must be creative, technically competent, understand economic and financial implications and be able to withstand cognitive dissonance for longer than usual periods of time, but he must also possess diplomatic skills. There is no appeal in this kind of work to this or next year's profit, growth, market share, successful research or design. The results may not show for 3, 5, or even 10 years, but they

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[1]One of the most serious developments in recent times has been the decision of groups to go 'over the edge', as in Northern Ireland, Cyprus, Lebanon, etc.

[2]Martino, J.P., "Evaluating Forecast Validity," in Bright, J. and Schoeman, M.E.F. (eds.), "A Guide to Practical Technological Forecasting," Prentice-Hall, N.Y. (1973) pages 27-52.

still may be decisive in terms of corporate, organizational, or departmental success. In one industrial company with some 10,000 total employees, a careful analysis of all the managerial and professional people suggested that only about 2-3% of them had this kind of combination of technical and personal skills. A wise management makes good use, therefore, of such people.

(vi) The other parties involved.

In their Science Council of Canada study on technology assessment (T.A.) Mike Gibbons and Roger Voyer[1] noted that T.A. was worth little unless it took into account the social consequences of technological change (the T.A. system); and that there was always a minimum of three social groups involved - the protagonists, the antagonists, and the group indirectly affected (normally negatively); and that all three groups should be involved in any T.A.

The Swedish analysis of possible futures also supports strongly the need for the public to be involved in its own future.[2] The problem in practice is to separate the discussion of alternative futures from the necessarily confidential matter of deciding between alternative futures, whether governmental, business, institutional, etc. It is too easy at present to equate open discussion with loss of confidentiality; on the other hand an informed public can more readily support longer term decisions in its own interests. The public has minimum interest in politicians fighting zero sum games (the lowest social gain situation) simply to not-lose their power, when the higher level games which individual human beings normally play, could give higher social gains plus an equal or better change of retaining power.[3]

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[1]Gibbons, M. & Voyer, R., "A Technology Assessment System: A Case Study of East Coast Offshore Petroleum Exploration," Science Council of Canada Background Study #20, Ottawa, 1974.

[2]Royal Ministry for Foreign Affairs, "To Choose a Future," Stockholm, Sweden, 1974.

[3]Howard, N., "Paradoxes of Rationality: Games, Metagames and Political Behavior," M.I.T. Press, 1971.

The process of involving the public in its future requires further experiment and development.

5. Analysis and Synthesis

What does all this add up to? If so many things are uncertain why bother? These are valid comments, but not good advice. We can do a great deal to define the major options open to any management in the future, and to outline the probable strengths and weaknesses of each possible course of action, but we can never give specific numbers at specific times,[1] only an indication of their relative likelihood.

In the terms of this paper - the nature of futures problems -, it seems easiest to adopt Eric Ashby's concept of requisite variety. This measures the number of possible states that a system can be in. The variety of even simple systems is, however, enormous. It has been calculated that, if the entire earth had been turned into and used as a computer, it could only have handled about 10^{92} bits of information, wholly inadequate for a du Pont or an I.B.M.

Thus, the handling of futures problems turns itself into finding ways and means of reducing requisite variety to manageable proportions.[2] Some ways of doing this include:

(a) Dimensional analysis.

In the same way that a grid system reduces the variety in searching for a place on a map, identification of the minimum number of dimensions required to specify a problem reduces the requisite variety enormously.

It has often appeared to the writer that this should be one of the key outputs from a conventional Delphi. Such an output is readily utilised in planning, since a company must devise policies which locate it appropriately on each meaningful dimension.

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[1] Profitability for one chemical plant completed in 1958 was predicted to two decimal places. It never worked during the first year due to trouble with compressor foundations. When a second, larger plant was built in 1967, profitability was calculated to one decimal place. This time the front ring on the main compressor flew apart! Shouldn't we calculate the likelihood that the profitability, etc., will fall within a certain range, and admit the variability of events?

[2] cf. Beer, Stafford, "The Brain of the Firm," Allen Lane, The Penguin Press, 1972.

(b) Minimum Interest Criteria.

Where interest groups are involved, it may be possible to write minimum levels below or beyond which they are unlikely to go. This is in effect stating that resources are allocated in terms of relative power, not in terms of economic efficiency.

For example, Figure 3 shows the basis for the calculation of the minimum amounts of food and energy required for the world population as it passes through its peak.[1]

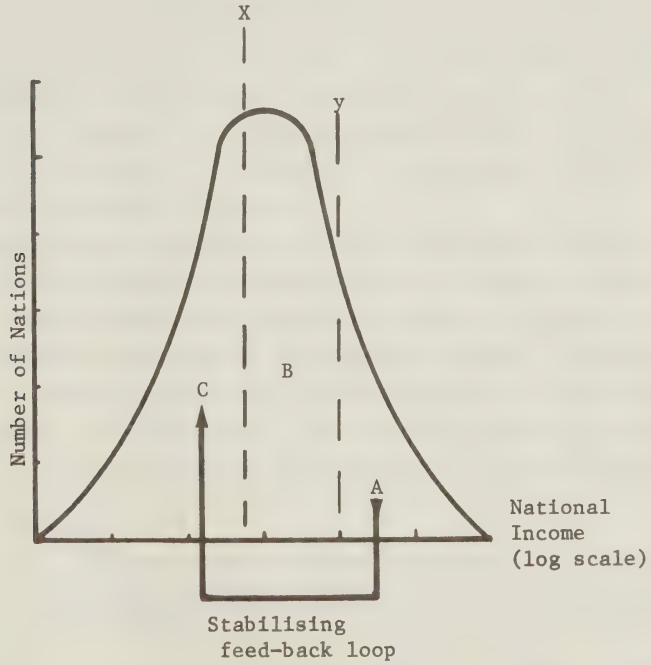

FIG. 3 - USE OF MINIMUM INTEREST CRITERION FOR WORLD REQUIREMENTS CALCULATION

The world is divided into three groups of countries, A, B and C. The area under the curve represents the total world wealth. The minimum interest criterion states that, in the limit, the rich countries,

[1]McHale, John and Magda, "Human Requirements, Supply Levels and Outer Bounds, " Center for Integrative Studies, State University of New York at Binghamton, 1975.

C, will find it in their own self-interest to transfer minimum sums of money to the poorest nations, A, such that the wealth-generating system is not undermined by disruptive actions by one or more of the B group countries. The boundaries, X and Y, are appropriately drawn. The criterion of pure self-interest has thus been used to reduce the variety of the problem to manageable proportions.

(c) Behavior Pattern Analysis.

As Coleman pointed out,[1] adaptive theories are better suited to complex problems than causal theories. Nowhere is this clearer than in the use of behavior patterns. The writer has demonstrated elsewhere that the high technology industries have followed an on-going behavior pattern for the past 25-30 years.[2] An operational classification of industry can be developed on this basis.[3] The method can be extended forwards to predict changes in behavior patterns.[4]

Behavior pattern analysis differs from systems dynamics and modelling in that it includes the human actors as separate elements in the system. Companies are run by people who carry a picture or perception of what the company is and what it is trying to achieve.[5] They impose this *gestalt* or viewpoint on to the purely technical, economic or financial aspects of any situation. The resulting decisions may be wise or less wise, but they include the ambitions of the people involved, the

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[1]Coleman, J., loc. cit. p. 8.

[2]Simmonds, W.H.C., "The Analysis of Industrial Behavior and its Use in Forecasting," Tech. Fore. and Soc. Change, 3, 205-224 (1972); reprinted in Bright, J., and Schoeman, M.E.F. (eds.), "Guide to Practical Technological Forecasting," Prentice-Hall, N.Y., 1973, 215-237.

[3]Simmonds, W.H.C., "Patterns of Industry Behavior and What They Tell Us," Chem. Tech., July, 416-420 (1975); Proceedings of the C.M.R.A.-C.C.D.A. Conference, St. Louis, Nov., 1973, 72-80.

[4]Simmonds, W.H.C., "Industrial Behavior Patterns for Planners," Futures, 7, #4, 284-292 (1975) "Planning and R&D in a Turbulent Environment," Research Management, Nov., 17-21 (1975); "Forces for Change in the Chemical Industry," Chemistry in Canada, 27, #10, 27-31 (1975); "Forces for Change in the Metallurgical Industry," C.I.M. Bulletin, March, 1976, and the Journal for Metals, Jan., 1976; "Forces for Change," Innovation Canada, 1975; Journal of the International Society for Technology Assessment (in press).

[5]cf. page 6.

friendships and the personality clashes, the power struggles and the ups and downs of real life. This broader, adaptive framework permits directions of change to be detected and their implications anticipated. The more complex, the more fluid, the situation, the greater the power, the greater the insight, of this kind of approach.

Summing-up, by identifying the nature of futures problems, it becomes clearer what futures work can and cannot do. We can identify the strengths and weaknesses of different methodologies on a rational basis, and will be better able to choose methodologies in relation to problems. The position of people working in this field and what they should and should not do is more certain, and the expectations of clients for futures work can become more realistic. There are sound advantages to be gained from a better definition of the nature of futures problems.

EXAMPLES OF PUBLICATIONS CONCERNING FUTURES RELATED STUDIES, METHODOLOGIES, ETC. IN N.R.C.

Author	Unit	Title	Reference
Associate Committee on Scientific Criteria for Environmental Quality		Status Report (annual)	February, 1975
	The report lists the functions of the Committee, its sub-committees, and the status of its reports on specific pollutants or situations, issued and pending.		
Associate Committee on Aerodynamics		"Recommendations for Aerodynamics R & D"	1974
	Survey of research areas to contribute to the future viability of the Canadian aerospace industry.		
Associate Committee on Automatic Control		"Operations Analysis, Process Design, Process Control in the Canadian Mineral Recovery and Metal Production Industries"	1972
		"Survey on a study of Computer and Process Control Applications in the Canadian Pulp and Paper Industry"	1974
	Study to determine the present position and future needs in control in mining, metal, pulp and paper industries.		
Bishop, C.T.	Division of Biological Sciences	"Report of the task force on industrial microbiology"	Internal report of 24 November, 1975
	Assessment of a university-industry-N.R.C. task force on the possibilities in microbial processes for industrial exploitation in Canada.		
Brown, W.C., et al	Electrical Engineering Division	"Computer-aided learning project" Establishment of objective and sub-objectives	Internal memo, 1969
		Program Planning & Analysis Group evaluation Achievements to date	Internal memo, March, 1972 Science Dimension, 4, #4, 14-19 (1972)
Brown, W.C.	Electrical Engineering Division	"A Cooperative Project for Research and Development in Computer Aided Learning"	Project Review, June, 1975
Campbell, W.F., et al	National Aeronautical Establishment	"Report of the motor vehicle accident study group"	N.R.C. Technical Note #7 Ottawa, May, 1966

Author	Unit	Title	Reference
Hutcheon, N.B.	Division of Building Research	"Research for construction"	Special Technical Publication #2, March, 1974 NRC 14005
Larkin, B.S. & Simmonds, W.H.C.	Division of Mechanical Engineering and Industrial Programs Office	"Relevance tree analysis of fluidics and fluid sensors"	June, 1971 (report not issued)
	Method failed; analysis could not be carried out in terms of one system (but in terms of needs or users).		
Miller, D.R.	Division of Biological Sciences	"Sensitivity analysis and validation of simulation models"	J. Theor. Biol., 48, 345-360 (1974)
		"Validation of ecological systems models"	J. Envtl Management
Miller, D.R.	University of Ottawa - NRC Div. of Biological Sciences Ottawa River Project	"Distribution and transportation of pollutants in flowing ecosystems"	Report #3, Jan., 1976.
	Third progress report on the physical and biological movement of pollutants in the Ottawa River.		
Quirouette, R.L.	Division of Building Research	"Towards a fire protection planning approach. 1. Concepts and development"	Internal report #418, May, 1975.
Templin, R.J.	National Aeronautical Establishment	"Low speed aerodynamics and the Science Council's national goals"	Report LTR-LA-71
	Uses the relevance tree method to estimate the 'value' of research in low speed aerodynamics to Canada.		
Thurston, F.R.	National Aeronautical Establishment	"National STOL program, long-term technological review"	March, 1972.
Vroom, A.H.	NRC Consultant	"Sulphur Utilization"	Oct., 1971 NRC 12241
	Study of potential research contributions to the utilization of the sulphur surplus.		

PAPERS DEALING WITH VARIOUS FUTURES ASPECTS BY W.H.C. SIMMONDS, INDUSTRIAL PROGRAMS OFFICE, N.R.C.

	PAPER	REFERENCE	REPRINTED
INDUSTRIAL BEHAVIOR PATTERNS			
Past	"Stepwise expansion and profitability"	Chem. in Can., 21, #8, 16-18 (1969)	Proceedings of the 12th National Meeting of the American Association of Cost Engineers, Pittsburgh, Pa., 1969.
	The reason why expected profits did not materialize in the petrochemical industry.		
	"The Canada - U.S. scale problem"	ibid, 21, #9, 39-41 (1969)	
	The influence of scale on the relative positions of petrochemical companies in the U.S. and Canada.		
	"The analysis of industrial behavior and its use in forecasting"	Technological Forecasting and Social Change, 3, 205-224 (1972)	Bright, J. and Schoeman, A., "A Guide to Practical Technological Forecasting", Prentice-Hall, N.J., pages 215-237 (1973).
	Groups of industries show similarities in behavior due to similar controlling factors which are identified.		
	"Industrial behavior patterns and their significance to British Columbia's industrialization"	Proceedings of the Association of Professional Economists of B.C. Conference, 'Whose Blueprint -- and When?' Vancouver, May (1973)	
	Application of the behavior pattern approach to the problem of industrialization in B.C.		
	"Why does the Chemical Industry change and move?"	Proceedings of the Vth Interamerican Congress of Chemical Engineering, Rio de Janeiro, July (1973)	
	Application of this approach to the development of the Brazilian chemical industry.		
Future	"Forces for change"	Proceedings of the Vth Innovation Canada Conference, Muskoka, Ont., Sept. (1975)	J. Internat. Soct. for Technology Assessment, (in press)
	"Forces for change in the Chemical Industry"	Chem. in Can., 27, #10, 27-31 (1975)	
	"Forces for change in the Metallurgical Industry"	Bulletin of the Canadian Inst. of Mining and Metallurgy, March, 1976.	Journal of Metals (in press)

PAPER	REFERENCE	REPRINTED
"Industrial behavior patterns: a new dimension for planners"	Futures, 7, #4, 284-292 (1975)	Research Management, 18, #6, 17-21 (1975)
"L'analyse des configurations du comportement industriel comme technique de prévision"	L'Actualité économique, 51, #2, 289-321 (1975)	

Application of the behavior pattern approach to predictions of the future of companies, the chemical and metallurgical industries, and to the problems of planning, based on the forces which bring about changes.

"The Nature of Futures Research"	Presented to the Science Policy Research Unit, University of Sussex, Oct. 1975, etc.	To appear as a special number of Technological Forecasting and Social Change.

Comparison of the characteristics of well-structured and ill-structured problems in terms of their definability, probabilities, measurability, and communicability.

RECLASSIFICATION OF INDUSTRY OPERATIONALLY

"A new classification of industry and its uses"	Circulated to the Interdepartmental Committee on Innovation, March (1972)	
"The analytical approach to industry classification"	Bulletin of the Classification Society, 4th Annual Meeting, Atlanta, Ga., April (1973)	
"Towards an analytical industry classification"	Tech. Fore. and Soc. Change, 4, # 375-385 (1974) NRC 13098	
"Industries reclassified: Today's behavior shapes tomorrow's results"	Proceedings of the Chemical Marketing Research Association - The Commercial Development Association, St. Louis Conference, Nov., 72-80 (1973)	Chemical Technology, July, 416-420 (1975)

Identification of the behavior patterns of groups of industries permits an operational classification of industry which can be used predictively (in contrast to the standard industrial classification which has no rational basis and cannot be so used).

PAPER	REFERENCE	REPRINTED
INDUSTRY-SOCIETY		
"Designing an industrial policy for Canada"	Proceedings of the IInd Innovation Canada Conference, Muskoka, Ont. Sept. (1972)	Mundell, Robert A. and van Snellenberg, B.E., eds, "Policy Formation in an Open Economy" University of Waterloo, Vol. 2, 447-470 (1974)
The influence of Canadian society on industry in Canada is traced and the common mechanism of development of both social and industrial attitudes, leading to the conclusion that industrial policy cannot be designed in isolation from society.		
"Dynamic interfacing"	Technology Assessment, 1, #4, 237-243 (1973) NRC 13482	
"The interaction of industry and society"	Proceedings of the Vth Interamerican Congress of Chemical Engineering, Rio de Janeiro, July, 1973	
The techno-economic and the human-social-cultural aspects of policies and projects must be brought together and interfaced before designs and specifications are frozen by either side.		
"Social, environmental and national criteria for chemical projects."	Chem. in Can., 26, #11, 21-24 (1974)	
Scientists must learn to look at the broad, as well as the narrow, aspects of their researches before embarking on or completing them.		
NATIONAL GOALS		
"Chemical engineers and Canada's goals"	Science Affairs, 5, #2, 48-49 (1971)	
"Social criteria: aid to new decision-making"	The Business Quarterly, 38, #2, 32-37 (1973) NRC 13351	
"Bridging the chasm: the next step"	Presented to the Canadian Association for the Club of Rome, 1st Annual Meeting, Ottawa, 1974	Tech. Fore. and Soc. Change, 6, 267-276 (1974) NRC 14139

PAPER	REFERENCE	REPRINTED
"Evolving our new socio-economic goals"	Presented to the Canadian Association for the Club of Rome, 2nd Annual Meeting, Ottawa, 1975	

Future studies require goals as part of their focus; these papers show how the new socio-economic goals of Canada can be derived.

PEOPLE

"How to make sure you have a future"	Innovation, #12, 36-43 (1970)	"Decision Making in a Changing World", Auerbach Publications Ltd., Princeton, N.J., 159-172 (1971).

The position of the *forecaster* as a person in an organization is considered (as opposed to forecasting).

"Advanced technology-master or servant?"	Proceedings of the Data Processing Institute, March, 163 (1973)	

Technology will advance fastest when its human and social potentials are recognized and incorporated into its progress.

"Estimating corporate requirements for engineers"	Report submitted to the Canadian Engineering Manpower Council, Aug., 1975	Engineering Manpower News, #6, Sept. (1975).

Estimates of future requirements of engineers by corporations can best be obtained by deriving them from estimates of future capital spending.

"Your career in cyclical situations"	Chem. in Can., (in press)	

Three major ways of planning an engineering career in the face of cycles in the economy.

"Through human eyes"	"Housing and People - L'Habitation et des citoyens" 6, #3 (1975) (in press)	

There are two dimensions in planning - the cost-benefit and the human-social-cultural. The importance of the latter has been overlooked during the economic growth spurt, but we must now learn to look at policies and projects *through human eyes*.